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## GALVANIC BATTERIES.—No. 1.

By GEO. M. HOPKINS.

THE principal galvanic batteries now in use will be described and illustrated in this series of articles. In the present article a number of simple batteries are figured and described.*

*The Earth Battery*, Fig. 1, consists of a zinc and copper plate buried in earth that is continually moist. The wire that extends from the plates to the surface of the ground must be insulated. The surface of the plates must be large, to insure good results; from 25 to 50 square feet are required to produce even a weak current. This battery furnishes a continuous current for a long time.

*Zamboni's Dry Pile*, Fig. 2.—In this battery the electromotors are tin or silver and binoxide of manganese. To construct one of these a piece of paper silvered or tinned on one side is taken; the other side of the paper is coated with finely powdered binoxide of manganese by slightly moistening it, and rubbing the powder on with a cork. Having placed together seven or eight of these sheets, they are cut by means of a punch into disks an inch in diameter. These

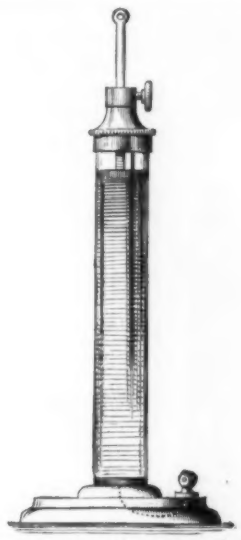


FIG. 2.—ZAMBONI'S DRY PILE.

disks are then arranged in the same order, so that the tin or silver of each disk is connected with the manganese of the next. Having piled up 1,200 to 1,800 couples they are placed in a glass tube, which is provided with a brass cap at each end. The lower cap is connected with the binding post on the base. In the upper cap there is a rod and knob by which the leaves may be pressed together, so as to produce a better contact. The knob in contact with the manganese corresponds to the positive pole, while the cap at the other end, which is in contact with the silver or tin, is the negative pole.

The dry piles are remarkable for the permanence of their action, which may continue for several years. Their action depends greatly on the hygrometric state of the air. Two thousand couples give neither shock nor spark, but can charge a Leyden jar and other condensers.

*The Voltaic Pile*, Fig. 3, consists of several compound pairs of zinc and copper plates put up in layers, always in the same order, and between each pair a moist conductor is inserted, such as a disk of felt, cloth or pasteboard, so that a succession of the bodies arranged on each other from top to bottom is as follows: Copper, zinc, felt, copper, zinc, felt. One end of the series terminates with zinc, and the other begins with copper. The pasteboard or felt disks are soaked in water mixed with common salt or sulphuric acid. The cut is about ¼ actual size.

*The Simple Zinc and Copper Battery*, Fig. 4, consists of strips of zinc and copper bent at the upper end and soldered together, as indicated in the engraving. The jars, which are about the size shown in the cut, are filled with water slightly acidulated with sulphuric acid. The expense of this battery is so slight that it may be used a few times, and then thrown away.

* For several of the engravings used in these articles we are indebted to *Electricity and the Electric Telegraph*, by Prescott.

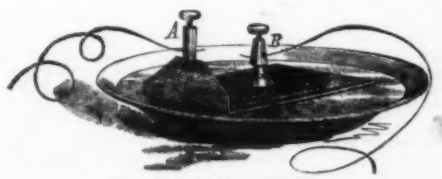



FIG. 5.—TOM THUMB.

*The Tom Thumb Battery*, Fig. 5.—This simple battery is constant for several days, and is sufficiently powerful to work the smaller electrical machines.

It may be constructed as follows: Take a piece, C, of common sheet zinc—stove zinc—six inches long, and four inches

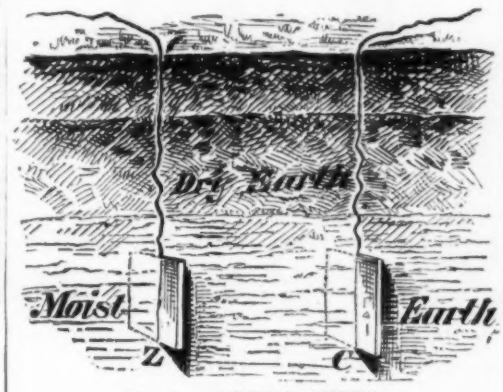
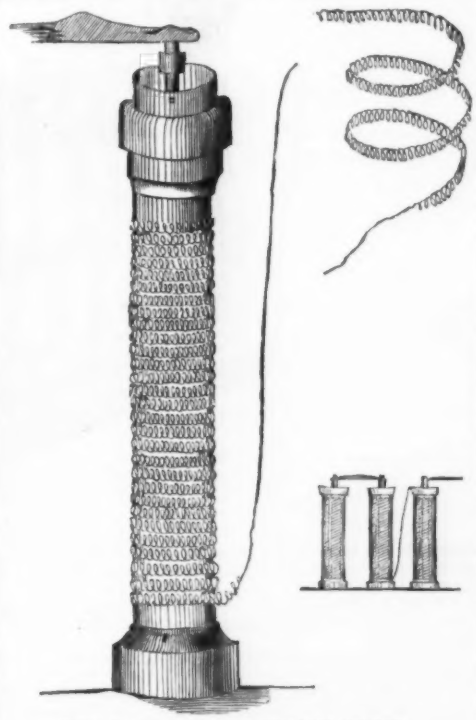



FIG. 1.—EARTH BATTERY.

wide; bend it up at right angles two inches from the end. Attach a binding post, A, or nick it, and wind around it a copper wire. Cover the zinc with two thicknesses of common white printing paper. A piece, D, of sheet lead of the same size as the zinc is bent up in the same way, or it is provided with a binding post, B, as in the cut. In a common tea saucer place one ounce of sulphate of copper, and



FIGS. 7 AND 8.—NEW SINGLE FLUID.

fill the saucer two-thirds full of warm water. Let it stand until dissolved. Place the zinc in the saucer, and put the lead on the zinc.

*Simple Single Fluid Battery*, Fig. 6.—M. Onimus recently exhibited to the French Academy of Sciences a new and simple battery, in which he substitutes a diaphragm of

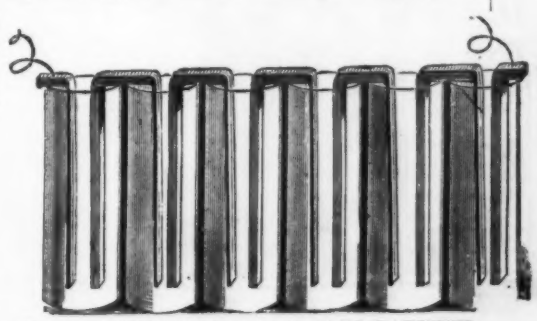


FIG. 4.—SIMPLE ZINC AND COPPER BATTERY.

parchment paper for the porous vase. The zinc cylinder, A, being enveloped in the paper, B, copper wire, C, is wound over all. The latter holds the paper against the zinc, and answers for a fastening. The whole is plunged in the sulphate of copper solution, and the battery soon works regularly. For some carbon batteries, the carbon is enveloped in parchment paper, and around this is placed either a zinc wire or a zinc cylinder. The battery thus constructed will, when moistened, work for some hours after being removed from the exciting liquid.

*New Single Fluid Battery.*—Figs. 7 and 8 represent a new cell invented by M. Pulvermacher. The accompanying figures speak almost for themselves. They show a porous jar surrounded by a silver thread. This thread is rolled to take a spiral form, and is used as the negative pole of the element. The exciting fluid placed in the unglazed jar percolates through the innumerable pores, and makes the electric contact with the cell complete. Externally the electric circuit is completed in the ordinary way. The positive pole is a rod of zinc, and the exciting liquid is dilute sulphuric acid, a solution of caustic potash or sal ammoniac. The

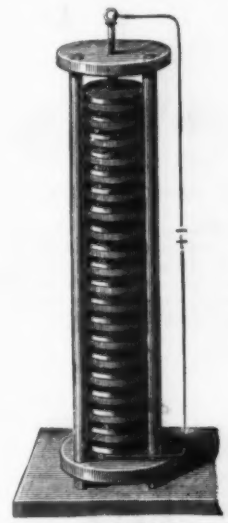


FIG. 3.—VOLTAIC PILE.

small spirals of silver or platinum wire are far enough apart not to cause capillary attraction to take place between them, but the wire makes an infinite number of contacts with the liquid that oozes from the pores of the jar. It is upon all these contacts that the air exerts its oxidizing action, and effects the depolarization of the cell. The top of the zinc is covered with caoutchouc in order to avoid accidental contacts which might short circuit the battery. The porous cell is surrounded by a ring of hard rubber, so that the whole cell is carefully guarded against harm.

The electro-motive force of a couple charged with a solution of caustic potash is about 1·5 volt; with dilute sulphuric acid—one of acid to ten of water—it is nearly 2 volts. The resistance of a cell with silver wire as the negative pole, and a porous jar of good quality, 14 centimeters high and 35 millimeters diameter, was 1·3 ohm. In a circuit having a resistance of 10 ohms, in ten minutes the electro-motive force diminished about 16 per cent., and returned to its normal value after three minutes' rest.

*Chloride of Silver Cell.*—Fig. 9 represents a small form of De la Rue's chloride of silver cell, which is remarkably well adapted for electrical testing either on shore or at sea. The engraving is about ⅓ the actual size. Its very

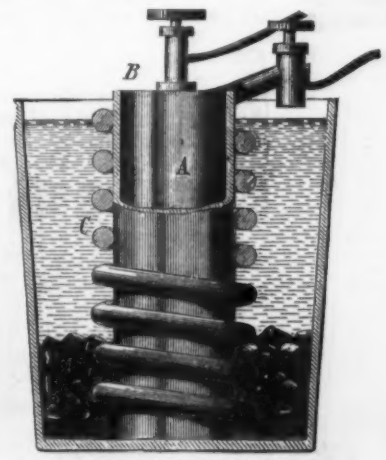



FIG. 6.—SIMPLE SINGLE FLUID.

constant electro-motive force from time to time, and especially during the taking of insulation resistance tests; its freedom from variation in electro-motive force when shaken or otherwise disturbed; its small portable form and cleanliness; and its comparative economy in the end, are special qualities in its favor. We hear that it is already coming into use as a testing battery.

In the diagram, A is a glass vessel, closed at the top to

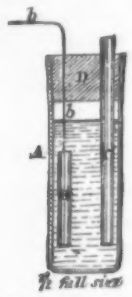



FIG. 9.—CHLORIDE OF SILVER.

keep out dirt by a stopper of cork or solid paraffine, D, but preferably of cork, because it can be handled with more ease and fits the cell more tightly than paraffine, which is apt to work loose when fitted to glass.

The negative pole, C, consists of a cylindrical rod of chemically pure zinc supported by the cork stopper, which is perforated to receive it. The zinc rod has a hole in the

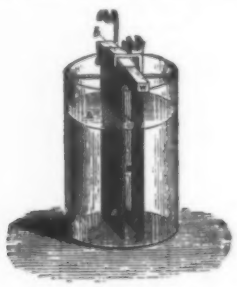


FIG. 10.—SMEE'S.

top to allow the silver connecting wire or electrode which goes to the next element to be soldered in.

The positive pole consists of a cylinder of silver chloride, B, having a silver wire or electrode, *b*, cast into it. This chloride rod is usually inclosed in a hollow cylindrical diaphragm of fine parchment paper.

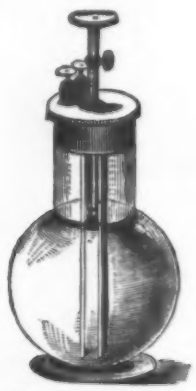


FIG. 13.—GRENET.

The solution for charging the cell is made by dissolving 23 grammes of pure sal-ammoniac or ammonium chloride in one liter of water.

The electro-motive force of each element is about 1·10 volt, and the internal resistance is about 8 ohms. Both of these qualities are very constant.

In the action of the cell, pure silver is reduced and deposited on the floor of the cell. To prevent the short circuiting of the poles by this metallic deposit, it is best to keep the zinc rod raised about three-eighths of an inch above the floor of the cell. This pure silver deposit can be readily turned into chloride of silver again by means of a small quantity of chlorine, and it is then only necessary to melt the chloride so formed, and recast it into rods for use over again, otherwise the pure silver may be sold as it is.

Twenty, fifty, or even a hundred of these cells can be fitted with solid paraffine into a small box easily carried in the hand, so as to form a convenient portable testing battery for the use of electricians abroad. For medical men employ-

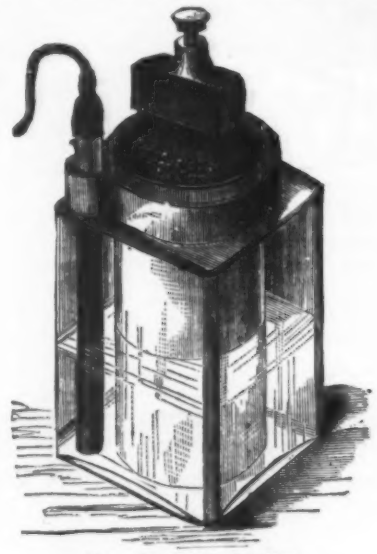


FIG. 12.—LECLANCHE.

ing the feeble current cure this cell is also highly convenient.

*The Smee Battery* is shown in Figs. 10 and 11. In Fig. 10, W is a wooden strip which rests upon the jar, A, and supports the platinized silver plate, S. The zincs, Z, are clamped to the sides of the strip, W, by a clamp, *b*, which is provided with a binding post for receiving a wire. A binding post is also connected with the silver plate, S.

The form of battery generally used for telegraphic purposes is shown in Fig. 11. It consists of a strip of platinum, one inch wide by ten in length, and a plate of amalgamated zinc fastened to a beam of wood by brass clamps both are

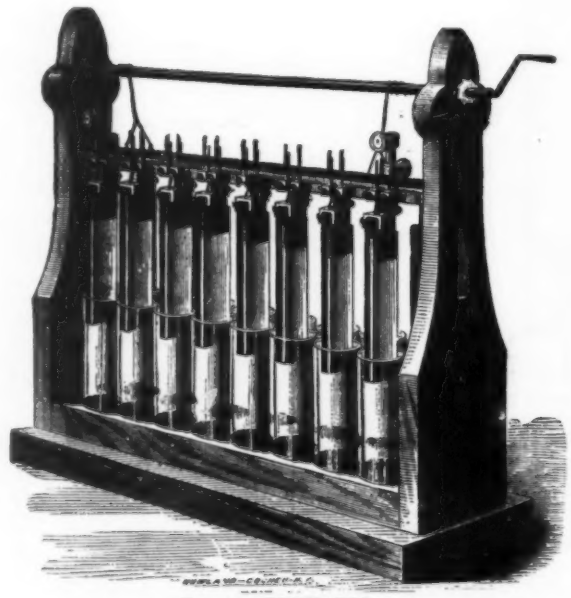


FIG. 14.—PLUNGING.

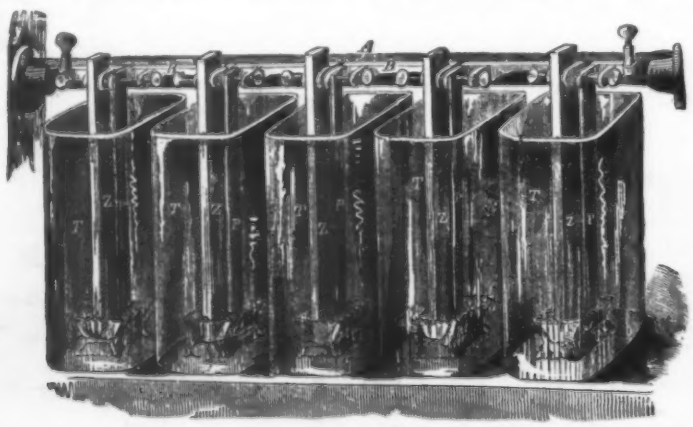


FIG. 11.—SMEE'S.

plunged into a glass vessel. In arranging a series of cells the zinc of one cell is connected with the platinum of the next.

A is an insulated wooden bar; B, brass clamps; Z, zinc plate; P, platinized silver plates or strips of platinum; T, glass cells.

The liquid generally used to charge the battery is 1 part of sulphuric acid to 10 of water.

*The Leclanche Battery*, Fig. 12.—The positive pole is composed of a plate of carbon set into a mixture of powdered peroxide of manganese and carbon, and hermetically sealed in a porous vase.

The negative pole is composed of a plate or pencil of amalgamated zinc. The two poles are set in a solution of sal ammoniac and water, contained in a glass jar.

As the zinc is indefinitely preserved without alteration in the sal ammoniac, and as the peroxide of manganese is insoluble in this liquid, no internal chemical action takes place when not in use.

The electro-motive power of Grove being 100, this is 75, and Daniell's 50; or three cells of this battery are equal to four cells of the Daniell.

Will last without renewal from one month to several years, according to use, at the end of which time the porous cells can be renewed at a moderate expense.

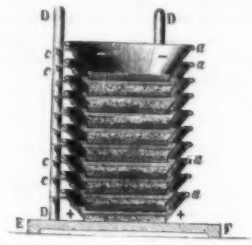



FIG. 15.—MARIE DAVY SULPHATE OF LEAD.

*The Grenet Battery*, Fig. 13.—This is a very good form of an experimental battery where constancy of current is not required, as, for example, in the laboratory and mechanical work rooms. The cell is in the form of a bottle, and contains a mixture of two parts of bichromate of potash dissolved in twenty parts of water and one part of sulphuric acid. The top is provided with a brass frame, to which is fastened a wooden cover, to which are attached two carbon plates, which dip permanently into the fluid; and between the carbon plates a zinc plate is suspended by a rod, by means of which it may be plunged into the fluid or withdrawn at pleasure. When the zinc is withdrawn the action ceases. This battery gives a powerful current for a short time, but it rapidly polarizes. The length of time during which the fluid will retain its power depends on the use which is made of the battery.

*The Plunging Battery.*—Where it is designed to have a battery for occasional service during a long time, the series represented in Fig. 14 is probably the simplest and most efficient yet devised. When not of service the plates are drawn up out of the influence of the acid, but always ready, upon turning the crank, to descend, and, after immersion, produce the required current. The smaller plunging battery employs glasses about one and one eighth inch diameter and four inches long, and the larger employs oval glasses of about three times the capacity. The plates are also made either of platinized silver plated lead, opposing zinc, or of carbon with zinc. With the former only dilute sulphuric acid can be used, but with the latter the bichromate solution may be used, thus giving very great electro-motive force—quite sufficient to ignite platinum at the distance of several miles, or to produce temporary but brilliant electric light. The cleanliness of the dilute sulphuric acid combinations, and the great length of time they can be held ready for service, make them extremely valuable.

When carbon and zinc plates are used, the bichromate solution given in description of the Grenet battery may be employed as an exciting fluid.

*The Sulphate of Lead Battery*, Fig. 15, is the invention of Marié Davy. It is constructed in the form of a column, and occupies but little room. It consists of a series of tinned iron pans, *a*, *a*, *a*, provided with three arms placed horizontally at equal distances apart. The bottom of each pan rests upon a zinc disk, and is coated inside with pulverized sulphate of lead moistened with water. The pans are piled one above another between three wooden posts, D, D, D, provided with iron screw heads, on which the pans rest by their three horizontal arms, *c*, *c*, *c*. The wooden posts are placed on a wooden frame, E, F.

The battery is charged by pouring water into the iron pans. The sulphate of lead is almost insoluble in water, but it is a good conductor of electricity. The zinc is attacked, the lead in the salt is reduced, and zinc sulphate and metallic lead is deposited on the bottom of each pan. The electro-motive force is inferior to that of Daniell, but its internal resistance is less.

The battery is easily kept in order, it being only necessary to add water from time to time, to supply the losses occasioned by evaporation.

[*To be Continued.*]

## THE WERDERMANN ELECTRIC LIGHT.

AMONG the most recent developments of the electric lighting system is that invented by Mr. Richard Werdermann, and which was lately shown at the works of the British Telegraph Manufactory, 374 Euston Road, to a number of scientific gentlemen and representatives of the press.

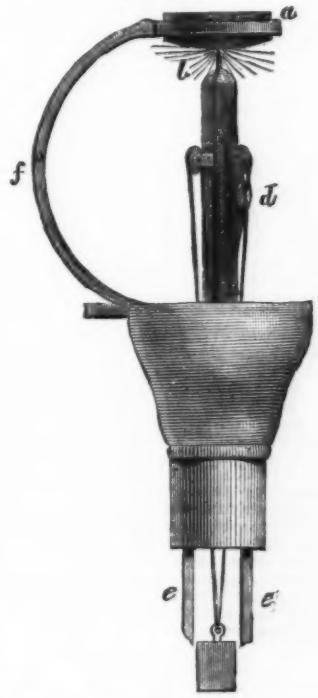
Mr. Werdermann was assisted in his experiments by Mr. Berger Spence and Dr. Cornelius Herz. The chief object of the inventor was to demonstrate that by the new system a considerable number of lights could be placed in one circuit and steadily maintained without the employment of any clockwork or electro-magnetic apparatus connected to the lamps.

The display was chiefly of an experimental character, the lamps used being somewhat different in construction to those which will be placed in actual work, but it was quite sufficient for scientific purposes.

The principle of Mr. Werdermann's invention consists in keeping a small vertical pencil of carbon in contact with a large horizontal disk of the same material above it. Mr. Werdermann was led to adopt this arrangement as the result of numerous experiments.

Referring to Fig. 1, which shows the ordinary arrangement of carbons in an electric lamp, it is well known that when the passage of the current is such that the top carbon is a positive pole, the end of this carbon becomes cup-shaped, while the end of the other carbon becomes pointed by the action of the current. By increasing the lower carbon considerably in sectional area, Mr. Werdermann found that, with the same amount of current passing, it was necessary in order to maintain the continuity of the arc, to place the two carbons closer together; he also noticed (as a curious fact) that a little cylindrical pimple of carbon was formed in the middle of the lower carbon electrode, as shown by the figure, also the end of the upper carbon tended to spread out. On still further increasing the size of the lower electrode, it was found necessary to bring the two carbons still closer together, in order to maintain the continuity of the arc; the little cylindrical pimple then became much smaller in size, and the end of the upper carbon spread out still more. If, now, the lower carbon was still further enlarged, so that it had a sectional area sixty-four times as large as that of the upper carbon, it was found that the continuity of the circuit could only be maintained by keeping the two carbons in actual contact, and further, it was observed, that the end of the upper carbon, which had

FIG. 1A.




THE WERDERMANN ELECTRIC LIGHT.

previously tended to spread out, now took a pointed form. When actual contact took place the little pimple of carbon disappeared, and a brilliant light was given out by the incandescent point.

Figs. 5, 6, and 7 show what occurred when the larger carbon formed the positive pole. Under these conditions the end of the small electrode became heated to a red heat only, while a small portion only of the large electrode became heated to a white heat by the passage of the current; this was also the case when the upper electrode was increased in size, and the two carbons had to be approached closer together in order to maintain the arc. When, however, the upper carbon was increased to such a size that continuity could only be maintained by actual contact, then a curious change took place; the upper carbon no longer glowed, but the point of the smaller carbon, previously only red-hot, now became white-hot, and assumed the conditions shown by Fig. 4. The light given out when the larger carbon formed the positive pole was found to be not quite so great as when it formed the negative pole. The heat being almost entirely confined to the smaller carbon, the larger one was not consumed to any appreciable extent.

During the whole time that the smaller carbon burns, it retains its pointed form, and a small electric arc is plainly visible round the points of contact of the two carbons. The greater part of the light given out is produced by this small arc.

In accordance with the foregoing results, Mr. Werdermann constructs his lamps in the following manner:

He places the negative electrode uppermost, giving it the form of a solid disk of carbon, about two inches in diameter and one inch thick. This is encircled by a band of copper ribbon and prolonged to a terminal to which one of the machine wires is attached. The lower or positive carbon, which is a thin round pencil, 3 millimeters in diameter, is placed vertically beneath the negative electrode, in a tube up which it slides. This tube has a prolongation of thick copper divided in two parts, and, pressing against the pencil and forming contact with it, this forms the other terminal of the lamp.

The lower carbon is kept in contact with the upper one by chains attached to its lower extremity, coming up over pulleys and down again to a counterbalance weight, which always keeps the point of the pencil in gentle contact with the disk as the former gradually burns away.

By referring to the sketch, Fig 1A, the general idea of the lamp will be seen at a glance.

*a* is the negative carbon, *b* is the pencil sliding in the tube, *e*, and gripped at the top of the tube by the split contact piece, the pressure of which is regulated by the spring, *d*. The conductors, *e*, form part of the lamp post, having terminals at the bottom, and one is connected to the tube, the other, by means of the semicircular piece of metal, *f*, to the upper carbon; *f* is hinged for the purpose of moving away the negative disk when a globe is to be put on the lamp

The tube is shown in perspective for the sake of greater clearness.

The experiments were commenced by putting two tall lamps in circuit such as will be used for outdoor lighting.

These lamps gave a light estimated at 360 candles each, and were connected together in parallel circuit. The lamps had no globes, and the lights were wonderfully clear, of a pure color, and perfectly free from the blue or purple rays so often seen in the electric arc. Better than all was the remarkable steadiness of burning, there being an entire absence of any jumping or flickering whatever.

After allowing these to burn for some time, the current was then sent through a row of 10 smaller lamps, arranged on a shelf, and connected parallel. These lamps were estimated to give about 40 candles each; each one burned with the same brilliancy and steadiness, and proved most conclusively that the divisibility of the light was an accomplished fact, and when we say that this satisfactory result was obtained with an electro-plating Gramme, the bobbins of which are wound with thick copper ribbon, and giving an electro-motive force of only 4 Daniell's cells, it seems probable and reasonable to suppose that with suitable machines, Mr. Werdermann will be enabled to put 50, 100, or even 500 lights in circuit, and thus solve the problem of dividing the light more completely than has hitherto been the case.

In fact, Mr. Werdermann stated that had his lamps been ready he could have put in circuit a considerably greater number of lights than were exhibited.

Fig. 2A shows the connections of the 10 lamps.

The thick wires + and — are the cables connecting the lamps with the Gramme machine, the first lamp on the positive being the last on the negative. The spirals, *a*, are equal resistances placed in the circuit of each lamp for the purpose of rendering any variation in the contact or pressure of the two carbons less appreciable to the passage of the divided currents.

The resistance, on the average, of each small lamp, including the extra resistance, *a*, is 0·392 ohm; 5 lights parallel is 0·076 ohm; 10 lights, parallel, as exhibited, is 0·037 ohm.

The resistance of the large lamp is rather less than that of the small ones. In the 10 small lamps the carbon pencils burn away at the rate of about 2 inches per hour.

The large lamps, having pencils of 4½ mm. diameter, burn from 2½ to 3 inches per hour.

The carbons are manufactured in Paris in lengths of about one yard, and at a cost of about 1 franc per yard, which length would keep up a light for 12 hours.

The negative disks are of ordinary battery carbon, and the weight required to keep carbons in contact is about 1½ lb.

The length of carbon protruding from the tube and made incandescent is ¾ of an inch, but this length can be varied at pleasure. However many lights may be put in circuit the extinction of one or more will not affect the rest, a switch arrangement attached to each lamp effecting all that is required for the regulation of the current.

Then again, by this system, all the lamps are lighted simultaneously, and can all be as readily extinguished, and again relighted.

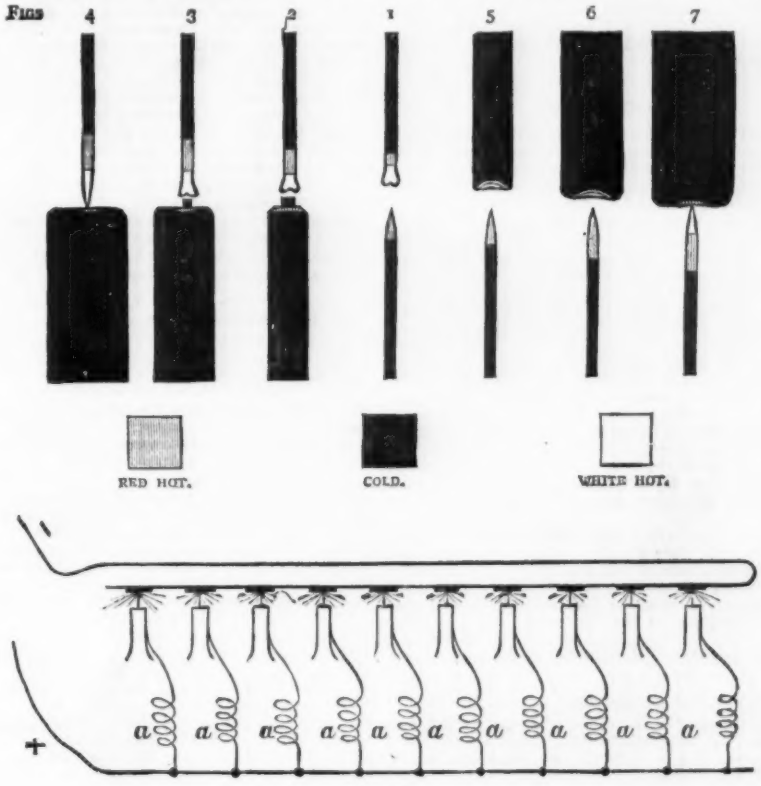



FIG. 2A.

## THE WERDERMANN ELECTRIC LIGHT.

In regard to the strength of this light, we have before observed that one object of the inventor is to moderate the intensity, so as to avoid having any of the illuminating power reduced by covering the lamps with opal or ground glass globes, as in other systems. The two large lamps did not dazzle the eyes, there being no change of color and no jumping, so it is, therefore, the intention of Mr. Werdermann to use ordinary glass globes, so that scarcely any loss of light will be incurred.

To some questions put to him by a gas engineer, Mr. Werdermann aptly compared the quantity of current with the quantity of a gas-holder, and the electro-motive force of the current to the pressure of gas.

For instance, if a gas-holder held sufficient gas, and had enough pressure to supply 100 burners, it would be necessary to increase the quantity and pressure of the gas to equally light 200 jets. It is the same with the electric light. If with one machine of given quantity and electro-motive force, 100 lights can be produced, then if 200 lights are required we must have a machine with a greater quantity of current (corresponding to the capacity of the gas-holder), and with greater electro-motive force to carry the lights further away (answering to the pressure of gas).

It may be mentioned that Mr. Werdermann does not believe in the divisibility of the current *ad infinitum*, as claimed by Mr. Edison, but that for practical purposes he has every confidence that the system we have described will solve the problem of general electric lighting, and that he will be able to carry the current to a considerable distance. Mr. Werdermann has already had numerous applications for the installation of his system.

In conclusion, we give some details of the machine by which the lights were produced. It is of the old form of Gramme electro-plating machine, with four upright electro-magnets, and two bobbins revolving between them. The bobbins are iron rings wound each with 48 sections of copper ribbon seven-sixteenths of an inch wide, and one-tenth of an inch thick. Each section has three convolutions. One bobbin is used for magnetizing or feeding the electro-magnets, the other for producing the working current. The resistance of this latter bobbin is about 0·008 ohm, and the electro-motive force, as before mentioned, is only four Daniell's cells, the machine being driven at a rate of about 800 revolutions per minute. The quantity of current produced is of course large; but as the intensity is very low, it follows that the insulation of the conducting cables could easily and cheaply be provided for.

The heating of the machine after several hours' continuous running was but very slight.

The power required to drive the machine is only two-horse power.—*Telegraphic Journal.*

## REPORT OF SOUNDS BY ELECTRICITY.

ONE of the many methods proposed for reproducing sounds at a distance from their source was recently presented to the world by M. C. L. Weyher, of Paris—at any rate his invention did not go beyond the stage of provisional protection. It consists of an apparatus for reproducing words, and likewise musical and other sounds, at any distance, for the purposes of communication, and for enabling theatrical and other public performances to be heard at localities distant therefrom. The apparatus consists of a thin sheet of iron, copper, or other metal, which is simply suspended or stretched on a frame at a convenient point in the theatre, hall, or room in which the music or other sounds are produced. This metallic plate is connected with one pole of a battery, the other pole of which is to earth, through the gas-pipe, for example; or if the distance be small a return wire may be used. A very light contact point is attached to a weak spring so as just to touch the metallic plate. This contact point is made of platinum, gas carbon, or other conductor of electricity, and communicates with the line wire going from the room in which the sounds are produced to the place where they are to be reproduced, and is there connected to an electro-magnet, from which the current again passes to earth. Above the electro-magnet is placed an iron or steel spring, forming a reed or vibrator, contained within an ear trumpet or sound box.

The action is as follows: Each sound produced in the theater, concert or other room, throws the metallic plate into vibration, and produces corresponding movements of the contact point, the vibrations being equal in number to the vibrations which produced the sound or note. Thus by this trepidation of the contact point the latter makes and breaks contact with the plate, and the circuit is made and broken at each vibration, the currents passing by the line producing the same number of vibrations of the reed or vibrator, which thus accurately reproduces the sounds with all their different intonations. The apparatus may be used for all kinds of telegraphic or other communications as well as for the transmission of musical sounds. A single line wire will serve for a number of receivers by using derived currents, or by passing the same current through several receivers. Several contact points may also be applied to the same vibrating plate for transmitting the vibrations along as many line wires. The battery may be placed at any point of the circuit, and may be under the immediate control of the person at the receiving end.

## ELECTRIC LAMPS.

AT the present moment the subject of electric lighting is attracting so much attention, and so much desire is expressed for information thereanent among many who have no special pretension to scientific training or experience, that perhaps no excuse need be offered for an attempt to describe, in a thoroughly popular manner, the different varieties of apparatus which are now being employed for the purpose of producing light by means of an electric current. At the outset, it may be as well to warn off technical readers, who are at once informed that they need look for nothing in the following description which is not well known to all whose duties or inclination have induced them to turn special attention to the matter. Apart from these, it is probable that there are many readers of the *Journal* who have not made themselves familiar with the theory of electric lighting, and to whom such an exposition as is here attempted may be not unwelcome. For the present it is proposed to treat only of the lamps employed. The electricity itself may, of course, be generated either by a galvanic battery, or by a machine driven from any suitable prime mover. The former source has been long employed, but it is the latter which is now invariably used for electric lighting on the large scale.

There are many varieties of machines, differing widely from one another in their details. Some of the more important varieties have already been described in this *Journal*,* but for our present purposes we shall have enough to do to consider the apparatus used to transform electricity into light, without touching on the generators which produce electricity, or rather transform into electricity the mechanical energy which in its turn has been derived by the steam-engine or other prime mover from heat.

### FORMATION OF ELECTRIC LIGHT.

Whenever a voltaic circuit, the circuit joining the two poles of a battery or magneto-electric machine, and along which the current flows, is ruptured, a bright spark is seen. If the two ends of the broken circuit are of carbon, the spark is specially vivid. If the current be of sufficient strength, the spark becomes a brilliant star of light, which remains so long as the pieces of carbon are not too far removed from one another. This star or band of light is, from its shape, known as the voltaic arc. Whenever the voltaic arc is formed between two pieces of carbon, the carbon is rapidly consumed, and, consequently, the space between the two pieces increases, until it is too great to allow the arc to be formed. The result is that the light disappears. It is, therefore, necessary to provide some apparatus which shall keep the carbons at the same distance apart, however fast they may waste away, so that the space between the two may always be constant. It is also a point of great importance that the distance apart of the carbons should be precisely that at which the most brilliant light is produced, since there will always be one particular distance at which there is such a result, and any excess or diminution of which has an injurious effect on the light. The various devices intended to effect this object are known as electric lamps or regulators, and it is by the use of one or other of these devices that all electric illumination has up to the present been effected. Certain other apparatuses, noticed below, depend for their action on other principles, but whatever may be the future use of these, it cannot be said that they have as yet established their practical value. Some of them are much too recent for any opinion to be formed about them.

The first and most obvious idea was to give such a motion to the carbons as would cause them to approach in a corresponding rate to that in which they were consumed. This is a good deal easier in theory than in practice. A uniform mechanical motion is by no means sufficient. The rate of consumption of the carbons is constantly varying. It varies with the strength of the current (and this in its turn is affected by any variation in the distance between the carbons) and with the nature of the carbons themselves. A further complication is introduced by the fact that the "positive" carbon wastes about twice as fast as the "negative" carbon, so that, to keep the light always in the same position, a corresponding motion must be given to each. The position of the carbons must, therefore, be controlled automatically by the current itself, so that as the light grows weaker they must be drawn apart or brought together, till that position is obtained at which the light has its greatest intensity. To effect this many very beautiful and ingenious arrangements have been devised. It would be impossible to give an account here of all these, but a few typical lamps may be described, to illustrate the principles employed.

### THE DUBOSCQ ELECTRIC LAMP.

One of the earlier and best known is that of M. Duboscq. In this, as in nearly all electric lamps, the carbon is in the shape of two rods, mounted vertically in the same straight line, one over the other, the upper end of the lower carbon touching the lower end of the upper carbon. The holders carrying the carbon rods slide up and down so as to separate or bring together the ends of the rods. In the stand, on which these holders are mounted, is a clockwork motion which slowly moves the upper holder down and the lower up, at about the same rate as the ends are consumed, thus the wasting away of the ends, and their approach to one another, proceed together at such a rate that they are kept at about the same distance apart. But, as stated above, the unvarying regularity of this mechanical movement is not what is required. The movement must accommodate itself to the variations of the electric current. To this intent the power possessed by the electric current, of magnetizing a piece of iron round which it flows, is rendered available. The current in its path is led through a coil of insulated wire surrounding a core of soft iron. Whenever the current flows, this iron becomes a magnet, stronger or weaker according to the strength or weakness of the current. When the ends of the carbons touch, the current flows without interruption, and its effect is then greatest on the magnet. As the carbons are separated, the obstacle to the free flow of the current is increased, and its effect on the magnet grows weaker and weaker until, when the carbons are so far apart that the voltaic arc can no longer be formed, the current is interrupted, and the iron core ceases to be magnetized at all. It is evident that the magnet may be caused to act on the end of a lever, so as to release the clockwork when the magnet is feeble, and lock it when it is strong. Suppose the carbons in contact, and a current of electricity passed through the apparatus. The upper carbon is raised (in the earlier lamps by hand), and the voltaic arc shines out. The carbons burn away, and as the widening space between them offers increased resistance to the current, the magnet grows weaker, till it ceases to attract the lever which locks the clockwork, and the carbons are brought nearer. Instantly the magnet is again brought into action, and the clockwork movement stopped. So the process goes on. In all the lamps now made on this principle a second movement is added, which acts in the opposite direction to the other, coming into play when the carbons are too near. This serves to separate the carbons when they touch, and thus enables the lamp to be lighted by simply turning on the current. The lever operated by the magnet is made to release either of two detents, or to lock both when the lamp is working properly.

### THE SERRIN ELECTRIC LAMP.

The Duboscq lamp has long had a rival in the Serrin, and by this it has now to a great extent been superseded. In the Serrin the upper carbon holder is made of considerable weight, so that it serves by its descent to drive the apparatus. By means of a train of wheels it raises the lower carbon at the required rate, as it slides down itself. The lower carbon holder is also attached to a little frame which is drawn down by an electro-magnet and raised by a spring. The lamp being in position, with the carbons touching, a current is sent through it. The magnet is rendered active and attracts the frame, lowering slightly the lower carbon, and so causing the appearance of the voltaic arc. As the magnet is weakened, the spring raises the frame, and, consequently, the lower carbon, thus, as the carbons approach, causing the current to act more strongly on the magnet, and enabling it to draw down the frame. There is thus a series of small oscillations up and down which corresponds with the variations of the electric current. Concurrently with these oscillations is a steady movement of the carbons, tending to bring them together, and corresponding with the wasting away of their ends. By regulating the distance between the poles of the magnet and the "armature" attracted by it, the action of the magnet, and, consequently, the distance between the carbons, can be minutely regulated. The lamp is also fitted with a locking device, which comes into action when the carbons are touching and no current is passing, but is released as soon as the current is sent through the apparatus.

### THE SIEMENS-HALSKE ELECTRIC LIGHT.

Another plan is employed in the Siemens-Halske lamp. In this, also, the weight of the descending upper carbon holder is caused to raise the lower holder, but the separation of the carbons is effected by a ratchet-wheel, worked by a lever, to which an oscillating motion is given by an electro-magnet. As the current acts strongly on the magnet, it causes it to attract the end of the lever, which then moves the ratchet-wheel one tooth forward, and the carbons are thereby slightly separated. But the lever in its movement also brings together two metallic points in the paths of the current, which allow it to pass direct to the carbons without traversing the coils of the magnet. Instantly the magnet is rendered inoperative, and the armature, released thereby, is drawn back by a spring. The metallic points are separated, and the current once more is obliged to take the longer route round the magnet. There is thus a constant oscillation of the lever, depending on the strength of the current, and so the carbon points are removed from each other at a rate depending on the strength of the current, while they are constantly brought near by a uniform motion approximately corresponding with their waste.

### ARCHEREAU'S ELECTRIC LIGHT.

In the lamp, again, of M. Archereau, a still different device is employed. In it is utilized the power possessed by a galvanic current flowing round a spiral, of attracting into the center of the spiral a bar of iron placed partly within it. The lower carbon carrier is mounted on the upper end of an iron rod, the lower end of which enters within the core of a bobbin of insulated wire, through the coils of which the current is led on its way to the carbon. The rod is supported by a weighted cord, which, when the lamp is not at work, keeps the top of the lower carbon in contact with the bottom of the upper carbon. As soon as the current flows, the iron rod is drawn down into the coil, and the carbons are thus slightly separated; the consequent weakening of the current prevents the further separation of the carbons, and they are thus maintained at the required distance apart. It is, of course, necessary that the weight should be carefully regulated to correspond with the magnetic influence of the bobbin. Though there are many obvious imperfections in this simple arrangement, it is yet frequently used for lecture and such like purposes.

### BROWNING'S ELECTRIC LIGHT.

One other regulator of this class also deserves notice from its extreme simplicity, that of Mr. Browning. In this the upper carbon holder slides down by its own weight, and when the lamp is not at work, the upper carbon rests on the lower carbon. The upper carbon is raised to cause the production of the voltaic arc, and is thus held by a keeper attracted by an electro-magnet. As the space between the carbons lengthens, the weakening current acts less powerfully on the magnet, the keeper is released, and the carbon falls, till its approach to the lower carbon enables the current to act more forcibly on the magnet, and the keeper, again attracted, grips the carbon, again to release it as the current falls off. It is needless to say that this simple device does not pretend to compete with the elaborate and sensitive lamps of Serrin and Duboscq. In more recent lamps by the same maker, the weight of the upper holder is utilized, as in the Serrin, to move both carbons, and the movement of the lower one is controlled by an electro-magnet. In the latest form of all, a spring is used, instead of the weight, so that the lamp can be set in any position.

The above are all examples of the same type of regulator. In all of them two rods of carbon, set end to end, are moved toward each other at such a rate as to compensate for their gradual consumption. The description of them may perhaps be sufficient to give a general idea of the conditions to be fulfilled, and of the only successful way in which, till lately, any attempt was made to fulfill them.

### LONTIN AND MERSANNE LIGHTS.

Before passing on, however, to speak of other and all recent systems, it may be as well to refer to the regulators of Lontin and Mersanne, both of which are now attracting some attention. The Lontin regulator is a modified form of the Serrin, the modifications being intended chiefly to enable several lights to be set in the same electric circuit. The Mersanne lamp, unlike those above described, is set with its carbons horizontal, and the movement is obtained as in the Siemens machine, but in a different manner, from a little electro-motor, worked by the magnet. It has the advantage of allowing the carbons to be fed in continuously without stopping.

### RAPIEFF'S LIGHT.

The Rapieff system does not differ greatly in principle from the preceding, but has the distinguishing characteristic of employing a pair of carbons, arranged like the limbs of a V, instead of a single rod both at top and bottom. The rods are all fed forward by weighted cords, and there is a lever operated by an electro-magnet, which raises and lowers the frame carrying one of the two pairs of carbons, so as to adjust their position as usual.

### REGNIER'S LIGHT.

In another class of lamps, disks or slabs of carbon are substituted for the rods, the disks or slabs being arranged so that the voltaic arc is formed between their nearest points. Some of the earliest lamps were constructed on this principle, and it has lately been revived by several inventors. M. Regnier has recently brought out a lamp in which two disks of carbon, closely approaching at one point of their edges, revolve slowly, so as to bring continually fresh surfaces to the point of combustion. By means of a regulating device, on the same principle as those previously referred to, the disks are brought together or separated as the current varies. This lamp is chiefly interesting as having led to the construction of a modified form of it, which really acts on a different principle, and is referred to below.

### THE WALLACE-FARMER LAMP.

Differing still further from any yet mentioned, but perhaps to be placed in this class, is the Wallace-Farmer lamp. In this, two oblong slabs of carbon are set, one above the other, with their edges adjacent. The lower slab is fixed. The upper one is capable of sliding up and down, so as to rest with its lower edge upon the upper edge of the lower carbon. The frame which carries this upper carbon is raised and lowered by an electro-magnet. The current, on being sent through in the usual way, brings the magnet into action, and this raises the upper carbon from the lower. The voltaic arc immediately forms, not along the whole length of the long slit or opening between the edges of the slabs, but at the point, wherever that may be, where they approach most nearly. The carbon is consumed at this point, and the arc shifts to the next nearest point, and so on, till it has eaten away the whole length of the edge and broadened the opening so far that the current can no longer cross the intervening space. Then the lamp goes out, or is readjusted by hand. There is thus no regulator, but the inventor relies on the length of time that elapses before the carbon is consumed along the whole length of the edge of each slab.

### JABLOCHKOFF'S LIGHT.

From the last named we naturally come to that remarkable invention which has been the principal means of drawing public attention to the electric light, the so-called "candle" of Jablochkoff. As in the Wallace lamp, there is no regulating mechanism, but the required object is attained in a perfectly different and original manner. Two rods of carbon are set side by side, with an intervening layer between them of china clay or plaster of Paris. Imagine a section taken along the length of an ordinary lead pencil so that there is left only the lead with a thin strip of wood on either side. The wood represents the carbons, and the lead the plaster of Paris, in a Jablochkoff "candle." When it is lighted the arc forms across from the end of one strip to the end of the other, the intermediate substance being fused. As the carbons burn down, the plaster of Paris between their ends is burnt also, and so the whole candle burns slowly away. It will be remembered that to form the voltaic arc it is necessary that the carbons should touch, and then be separated. To fulfill this condition, the upper ends of the carbons are connected by a thin strip of carbon, so thin that the current in first passing through it burns it away. This has the same effect as if the carbons were first caused to touch and then separated.

But the voltaic arc is not the only source of electrical light, though it is by far the most vivid. It is not necessary to actually interrupt the circuit to obtain light. If in the course of a circuit along which the current is steadily flowing there is introduced any substance which, while allowing the current to pass, yet offers considerable resistance to its passage, heat is produced, and, under certain conditions, the substance becomes incandescent and gives out light. Thus, if portion of a circuit be of thick copper wire and portion of fine platinum, the platinum may be made to glow with a white heat, and even be fused, while the copper is not sensibly warmed. Many inventors have endeavored to construct lamps on this principle, but as yet with only a moderate amount of success. M. Jablochkoff in this way renders incandescent a slab of kaolin (china-clay), by sending through it a current of an induction coil. Several inventors have rendered a thin rod of carbon incandescent while it was enclosed in a receptacle filled with nitrogen, so that it was prevented from burning away, as would be the case with carbon heated to a white heat in the air.

### WERDERMANN'S LIGHT.

Quite recently M. Werdermann has shown some experiments in which the end of a carbon rod is thus rendered incandescent in the air, but the rod is fed forward as fast as it is consumed. He employs a large bun-shaped piece of carbon, the round side of which is turned downward. Against the center of this lower side rests the top of a thin rod of carbon which, by means of a weighted cord, is pressed up into contact with the larger slab. A short distance down from the top of the rod is a metal contact, by which the current enters the rod. It traverses the short distance to the top of the rod, passes into the large carbon, and away in the usual manner. The short piece of thin rod offering a much higher resistance to the current than the rest of the circuit, it becomes incandescent, and burns away, but con-

* Many of the machines employed were described in an article in the *Journal* for Sept. 23th, 1877, p. 979, vol. xxv.; and in Dr. Paget Higgs' paper, *Journal* for April 5th, 1878, p. 392, vol. xxvi.

tact is kept up by the rod being continually forced upward by the weight. A somewhat similar device is employed by M. Regnier, who has, in one form of his disk-lamp, substituted a rod for one of the disks. He, unlike M. Werdermann, places his thin carbon uppermost, and allows it to rest on the edge of the revolving disk.—*Jour. Soc. Arts.*

## FORCES IN THE TELEPHONE.

WITH a view to obtain some data regarding the order or amount of mechanical and electrical forces which come to play in Bell's telephone, M. Bosscha has recently made some experiments (*Archives Neerlandaises*). To the middle of the plate of a telephone he attached a stiff hair, and pointed a microscope on the rough part of the hair; the microscope sufficing to measure accurately displacements of the plate of about a thousandth of a millimeter (*m.*). The intensity of the current going through the telephone was measured, along with the corresponding displacements, and it was found that the intensity 0·1627 Weber's unit corresponded to a displacement of 5·77 *m.*; the intensity 0·2337 to 7·77 *m.* Hence for unit current we have a displacement of 34·3 *m.* Other telephones, naturally, gave other values.

By insertion of large resistance, the current was now weakened down to the limit of audibility of the sound produced by it, and this limiting value was for four different telephones:—

| Intensity. | | | |
|---|---|---|---|
| 0·000100 | 0·000153 | 0·000084 | 0·000066 |
| **Displacements.** | | | |
| 0·00225 *m.* | 0·00133 *m.* | 0·00288 *m.* | 0·00237 *m.* |

The smallest displacements of the plate, therefore, which still gave a perceptible sound, have the value 2½ thousandths *m.*, or about 1-200th of the wave length of yellow light.

If periodic interruption was used instead of single interruption, as with Reiss's telephone for production of tones, a tone could still be distinctly heard with a current whose intensity = 0·0000155; hence it follows that attenuating currents of an intensity = 0·0000077 would still produce a perceptible tone. Very probably the under limit is still lower.

M. Bosscha further inquired as to the quantity of electricity which corresponds to a certain displacement of the plate. When one speaks before the instrument with the ordinary voice, the excursions of the plate are so small that they cannot be measured. M. Bosscha thinks it probable that the oscillation of the attached air did not amount to 1-millionth mm. To this displacement corresponds (in the resistances of the telephone in question) a current of 0·0000091 electro-magnetic units. A tone of 880 simple vibrations, which would communicate to the plate vibrations of 1 *m.* amplitude, must produce, in the circuits, currents with a mean intensity 0·0000799, which, according to the foregoing measurements, give in the receiving telephone a perfectly distinct tone.

"The uncommon sensibility of the plate of the telephone," says M. Bosscha, "and the not less surprising sensibility of the human ear render the telephone a valuable instrument for recognizing in electric currents peculiarities which hitherto no other instrument could reveal. Thus applied to the conductor of a Holtz machine, the telephone enables us to perceive the periodicity of the electric motions in a conducting wire. We may easily convince ourselves that the pitch of the tone in the telephone, when the disk of the machine is turned with moderate velocity, depends on the resistance of the circuit and the capacity of the condensers. If the current of a Holtz machine be sent through a Geissler tube, the resistance of the circuit and the capacity of the condensers may be so regulated that distinct stratifications are obtained in the tube. The telephone shows that the arrangement which produces this action corresponds to a determinate period of electric discharges."

[Continued from SUPPLEMENT No. 156, page 2480.]

## ARTESIAN WELLS.

WELL No. 25 on the map is 157 feet deep. In boring it 50 feet of quicksand was passed through.

No. 26, 140 feet deep; quicksand, 40 feet.

No. 27, depth, 95 feet. This is a flowing well, and cannot be lowered by pumping, and is pure, cold, soft water. Sand, 29 feet; clay, 6 feet; black mud, 10 feet; yellow clay, 8 feet; quicksand, 15 feet; black clay, 4 feet; marl, 9 feet; broken sandstone, 8 feet; sand and gravel, 8 feet.

No. 28, depth, 130 feet. This is a flowing well, and cannot be lowered by steam pump, and yields pure, cold, soft water. Sand, 28 feet; blue clay, 12 feet; yellow clay, 15 feet; sand, 14 feet; blue clay, 8 feet; yellow sand, 15 feet; quicksand, 10 feet; soft sandstone, 12 feet; blue clay, 4 feet; washed gravel and sand, 6 feet.

No. 30, 160½ feet; sand, 60 feet; clay at the bottom. Across the street from this well another went 142 feet, passing 40 feet of black sand.

No. 31, 141½ feet; sand, 60 feet; all hard sand and water down.

No. 32, depth, 98 feet. Water rises to surface, and has been pumped at the rate of 88,000 gallons per day, lowering it 20 feet only when it comes to a stand, and can be lowered no farther. Strata passed: Sand, 31 feet; blue clay, 14 feet; quicksand, 12 feet; yellow clay, 5 feet; sand, 18 feet; hard pan and soft sandstone, 10 feet; sand and gravel, 8 feet. At this depth struck bedrock, after bringing up chips of redwood; the lower stratum of sand contained gold.

No. 33, depth, 125 feet. Pure cold water, sufficient for all purposes intended. Sand, 31 feet; blue clay, 7 feet; sand, 20 feet; yellow clay, 3 feet; quicksand, 25 feet; light blue clay, 12 feet; sand, 10 feet; flinty sandstone, 9 feet; sand and gravel, 8 feet.

No. 34, 116 feet deep; water at 90 feet; rock at the bottom. Between 34 and 20 there is said to be about twenty-five wells.

No. 35, 128 feet deep. Yields a large amount of water for laundry and dwellings. Strata: Sand, 35 feet; blue clay, 9 feet; hard pan, 8 feet; yellow sand, 15 feet; yellow clay, 10 feet; sand, 12 feet; blue clay, 4 feet; quicksand, 16 feet, soft sandstone, 12 feet; sand and gravel, 7 feet.

No. 36, 157 feet deep; quicksand, 60 feet.

No. 37. This well has already been spoken of as obtaining no artesian water at a depth of 212 feet, though so near to good wells. Quicksand, 24 feet; then hard sand without water, 80 feet; then blue clay all the way down. At 180 feet struck a log, perhaps manzanita or sycamore.

No. 38, 121 feet to black rock; pure water.

No. 43. A well in this neighborhood struck water at 57 feet, but not sufficient supply; at about 80 feet gold-bearing gravel was met with; at 93 feet vegetable matter was brought to the surface. Dr. Joseph Le Conte pronounces it coniferous wood, and *probably* the root of redwood. At 120 feet this well struck a supply of water.

These wells illustrate well the general theory of artesian wells. The water, falling upon the surface, flows along until it reaches pervious ground, when it sinks down, with greater or less rapidity according to the nature of the material, until it reaches some stratum through which it cannot pass. On this it accumulates, running always to the lowest points. The pervious material on the surface at San Francisco is generally sand, which has been blown in from the ocean, or has been used in filling. The impervious strata which collect the water are composed of clay or rock, the deepest stratum, on which lies the best water, being overlaid with a gravelly, porous conglomerate.

On examining the data of the above wells it will be found that sand is generally passed through first, then clay, then sand again succeeded by clay, then sand again with the water-bearing gravel. Above both the first and second clay water may be obtained, but being more or less contaminated with the surface drainage of the immediate vicinity, is passed through and neglected by those wishing good wells.

The average depth of the deeper wells is 150 feet, the shallower ones ranging from 70 to 100 feet, but whether in all cases the shallow and deep ones are fed from different sources it is not possible to decide from the data. At a depth of from 150 to 200 feet, and in some cases less, rock is struck which has been bored into hundreds of feet without water being obtained, as for instance in wells 39 and 40, as mentioned in the last issue. It is said that this same rock has been bored into at Benicia, the Government well there being 1,500 feet deep, but at that depth no water is obtained. We know of no satisfactory account of the geological character of this rock. If this were determined, it might be stated definitely whether or not it does outcrop far in the interior, and hence, whether or not water may be expected below it flowing under us to the west far out to sea.

It is difficult to determine in exactly what manner the water occurs under us. The Geological Survey gives no account whatever of the position of the strata in the city, further than that it is the most chaotic jumble to be found in the State. This is due, it is said very indefinitely, to the "influence of the east and west line of depression by which the 'Golden Gate' has been opened." However, the strata which have been covered up by the drift of sand correspond to strata found on the east slope of the Santa Cruz mountains in Santa Clara valley. In this valley the east and west compression which forced up the mountains elevated the strata with considerable regularity, so that they dip gently to the east. If this had been the case in our vicinity, we should expect the strata in the region represented by our map to dip in the same general direction. But the "influence of that break" has interfered with this. Figs. 4 and 5 show a general inclination of the surface from northwest to southeast, and lines joining the bottoms of the wells correspond to this with some regularity. By comparing Figs. 1 and 3 with Fig. 4, it will be seen that a depression exists running from northwest to southeast, in which wells 36 (Fig. 1), 38, 28, 25, and 26 (Fig. 3), and 1, 35, 25, 28, 31, and 32 (Fig. 4) are bored.

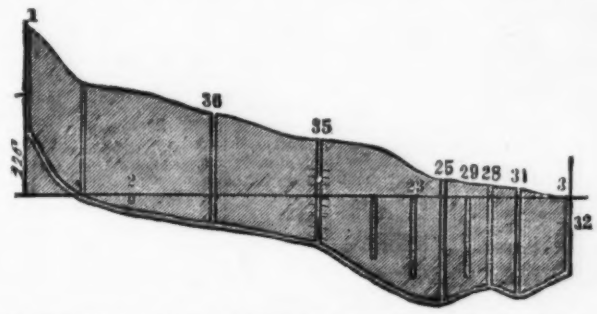



FIG. 4. PROFILE FROM SCOTT AND CLAY TO FOLSOM AND SIXTEENTH.

The other profile line from northwest to southeast (Fig. 5) may represent the general direction of a similar depression on which very many of the wells have been bored.

However, it is impossible to tell just how the water lies. The general impression is that it is to be found in the beds of old streams, of the direction of which each well borer may have his own ideas. The finding of gravel in the successful wells and the existence of spots barren of water, go to prove this. Wells 8 and 37 (Fig. 2), already mentioned, furnish an example. A well between 6 and 7, 260 feet deep, gives little water, while just across the street another well, only 82 feet deep, gives three times as much. In the neighborhood of wells 22 and 42 wells were run down about 80 feet to the rock. They ran through clay and clean sand, but gave nothing but salt water. Just across the street again a well, 120 feet deep, furnished excellent water. Between 19 and 16 several attempts to obtain water were made before a good well was obtained. In the space of about a block four wells were bored. The first struck rock at 16 feet; the next at 30; another at 70, and still no supply of water, but after thus feeling around, a fourth, 75 feet deep, flowed over the surface.

If there are channels underneath us in which the water runs, when and just how they were produced does not appear. They do not always correspond to present channels. The last named case is a proof of that, for the well that struck rock at 16 feet is very near the mouth of an old creek, as will be seen by referring to Fig. 2. Again, a well in the mouth of Islais creek, south of the city, proved a failure at about 140 feet. Wells very near the lagoon which puts up toward Tamalpais, back of Saucelito, in Marin county, where the formation is, we believe, the same as on our peninsula, also were failures. It would certainly be interesting to have some map of the country when the channels of these now underground streams were scoured out. In some views it looks more as though the successive layers of gravel, clay, sand, etc., had been pressed up into a series of waves, and that the water seeks now the troughs of the waves.

The interesting and unanswerable question now arises as to where the water comes from. Most of it, in the deeper strata at least, must be admitted at or near the outcrop. This outcrop may be around the bases of the hills and covered up in the large tracts of sand toward the beach. It has been estimated that 15,000,000 gallons of water is pumped daily from San Francisco artesian wells. That would make 5,475,000,000 gallons per year. If we consider the whole surface of the country as catching water for our wells (which is not the case), and take 23·3 inches as the average yearly rainfall, we would have a supply of 17,809,000,000 gallons per annum, or three times as much as is now used. But even considering that this much were furnished, it seems impossible that even the amount now obtained could be made available. For the artesian water is under pressure. Moreover, it has connection with the bay, as is proved by the effect which the tide has upon the level of the water in wells near the shore. This would indicate a constant flow into the bay.

And it seems highly improbable that even the present supply could be sustained if the catchment surface is only our own neighborhood. It may be that not all the strata outcrop under the bay, in which case some of the supply might come from the other side. Ignorance of the relations of the strata on this side to those on the other prevents any attempt at judgment on this question. A well at Oakland point, 206 feet deep, is affected by the tide, and from this it may be surmised that if strata extend unbroken from this side to the other they must dip very much to the east.

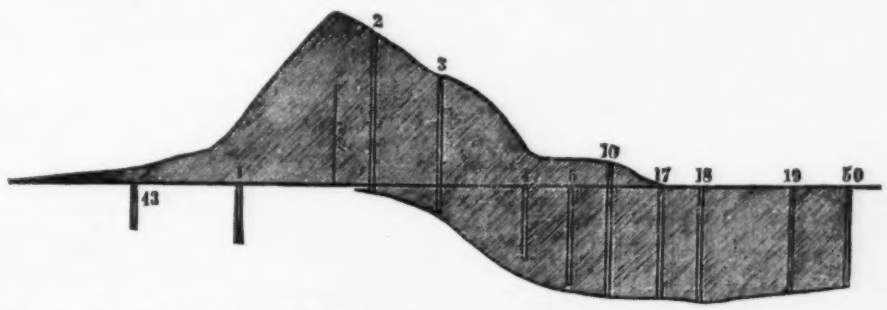



FIG. 5. PROFILE FROM SCOTT AND LEWIS TO BRANNAN AND SIXTH

## THE SOUTH PACIFIC COAST RAILROAD.

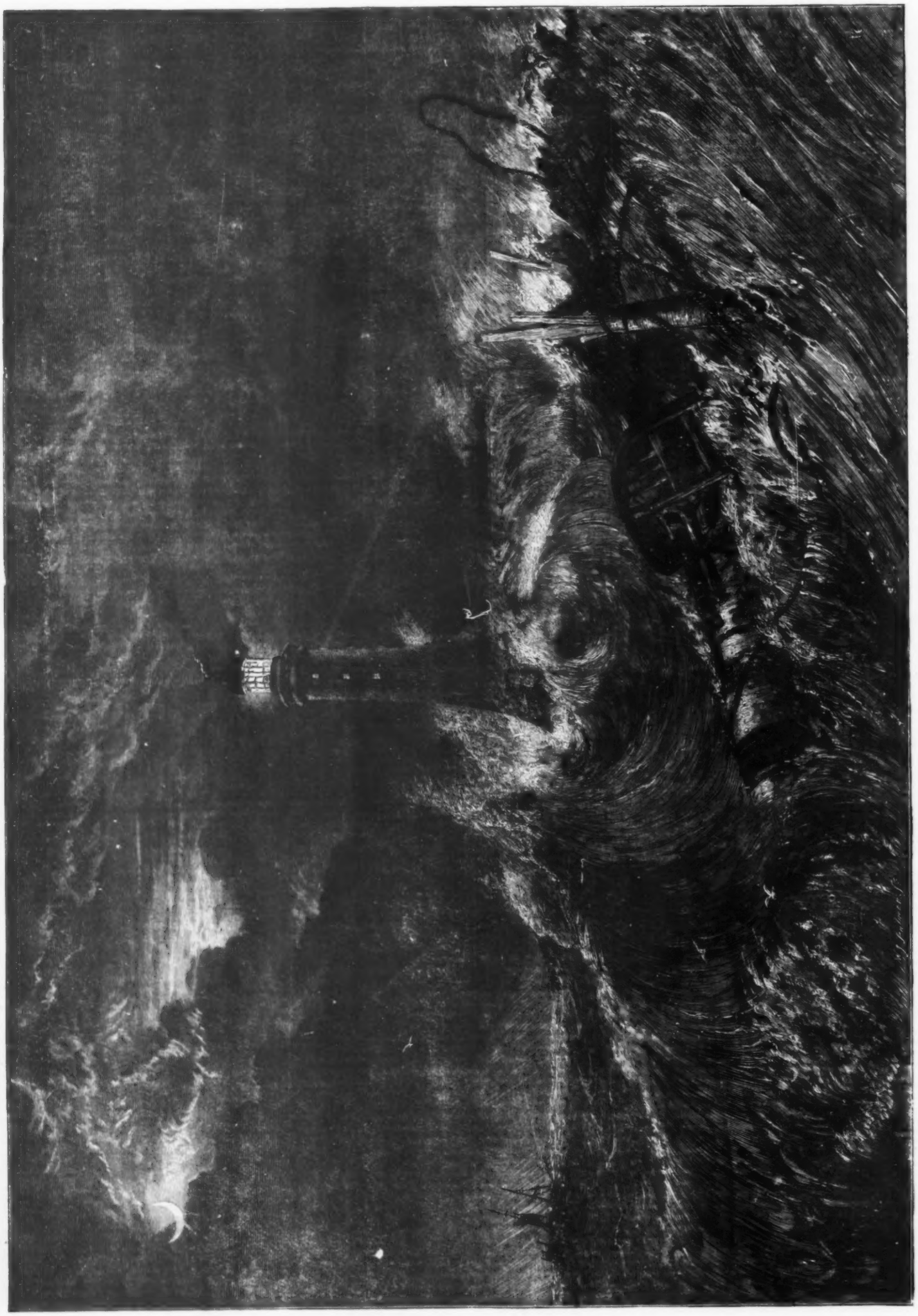
WE have watched with much interest the growth of this new and promising road, which we have already noticed at some length in the *Press*. Since that time the line has got into running order, and now makes regular trips from San Francisco to Alma. The new ferryboats, the Newark and the Bay City, are as fine as any on the bay, and make the trip across to the creek landing in less than half an hour. The wharves, slip, and offices at the mouth of San Antonio creek are very nearly completed, and everything is in good working order.

From Mr. E. H. Mix, the engineer in charge of the mountain work, we learn the following particulars of the progress at this end of the line:

In tunnels Nos. 3 and 4 a distance of 736 feet was made in the month of September. At the first of October the north end of tunnel No. 3 was in 1,426 feet, the south end, 487 feet. The south end is now located in good solid ground, though the first hundred feet through the overlying strata was in very insecure and difficult ground. The east end of tunnel No. 4 is in 672 feet, the west end, 574 feet. Tunnel No. 5 has been located, and ground is broken at both ends. It will be 910 feet in length. The road is laid to the third crossing of Los Gatos creek, or two and a half miles above Alma, and is expected to reach the mouth of tunnel No. 3 in five or six weeks.

The mountains through which these tunnels are being built seems to be a sandstone, covered with overarching layers of schist. The whole of this sandstone is more or less thoroughly impregnated with hydrocarbons similar to petroleum. At various times "blowers" of gas have been struck, which have given rise to slight explosions, but no accident has as yet resulted This dissemination of hydrocarbons seems to be quite widespread throughout these hills, as we shall hereafter take occasion to notice.

The expectation is that the road will be in complete running order (as far as Santa Cruz) by the year 1880, and unless a great change in human nature occurs before that time, we venture to predict a heavy travel attracted that way by the beauty of the mountain scenery—*Min. & Sci. Press.*



THE EDDYSTONE LIGHTHOUSE.—FROM THE PICTURE BY J. M. W. TURNER, R.A.

## THE EDDYSTONE LIGHTHOUSE.

OUR engraving will be recognized as one of those fine works of Turner's which have long commanded the admiration of all lovers of art. It is scarcely a fortnight since there was an alarming rumor, prevalent during a few hours, at Plymouth, of the disappearance of the light on the Eddystone Rock, which should be visible, under ordinary conditions of weather, from Plymouth Hoe. That rumor was happily dispelled in the course of the same night; but it has lately been made known, from a careful official examination, that the rock upon which the tower is built actually betrays symptoms of being undermined by the force of the waves, and the Trinity House corporation have already begun the construction of a new lighthouse upon one of the neighboring group of rocks, which are twenty-three in number, to supersede the admirable structure of dove-tailed stone masonry, erected by Smeaton a hundred and twenty years ago. The Eddystone Rocks are situated fourteen miles southwest of Plymouth Sound, and in a line with the Lizard Head, on the Cornish coast, and Start Point, on the southernmost shore of Devon. At high water the rocks are barely visible; at low tide several broken ridges of gneiss appear above the sea, the waves making a terrible riot over them when the southwest wind is blowing up the British Channel. The first lighthouse, a fantastic edifice resembling a Chinese pagoda, was constructed in the reign of William III., by an amateur, Mr. Henry Winstanley, an Essex country squire, but was swept away by the first November storm, when poor Mr. Winstanley, with several of his workmen and servants, were in the lighthouse, and perished with it; their bodies were never found. The next architect on those sea-beat rocks was John Rudyerd, a mercer of Ludgate-hill, who in 1709 completed a very compactly framed structure of oaken timber and granite, laid in alternate courses, and welded together with iron clamps and bolts, rising to the height of 69 ft. upon a base of 23 ft. square, and containing four rooms, one above the other, with an octagonal lantern. This was destroyed by fire in 1755, and one of the keepers was killed by the molten lead of the roof, some of which poured into his open mouth as he lay prostrate, and entered his throat and stomach. The third and present Eddystone Lighthouse was built, from August, 1756, to October, 1759, by John Smeaton, of Hull, one of the most eminent of English engineers, whose life has been written by Dr. Smiles, along with those of other great conquerors in works of mechanical science and public utility. His idea was to compose the lower courses of building of very large slabs of stone, cut so as to dovetail into each other and into the cut surface of the rock, forming a compact mass in the shape of a circular disk, all the pieces being secured by oaken wedges and by cement, with central plugs of hard marble, driven through a hole bored in the middle of each course, pinning the course together. There are twenty-four such courses in the solid part of the building, which stands 35 ft. 4 in. above its base and 27 ft. above the top of the natural rock. Its nethermost course, being set in a deep cavity of the rock, consists but of four laid stones, one of them weighing 2¼ tons; the second course is of thirteen stones, the third of twenty-five, and the fourth of thirty-three. The ordinary wash of the tide reaches the sixth course. Above the solid portion, which is really a pillar of jointed stones, rises the tower of three floors, containing a store-room, without windows, an upper store-room, a kitchen, a bed-room, and the top lantern, altogether 70 ft. in height; the rooms, which are circular, being 12 ft. 4 in. of diameter, with walls more than 2 ft. thick. This is the Eddystone Lighthouse, which is, so far as concerns the artificial building, quite as strong and good as it was in the first year of King George III., and would probably outlast Plymouth Breakwater, if the rock beneath Smeaton's structure did not begin to give way. It is understood, however, that the new Eddystone Lighthouse, now to be erected, will more than equal its predecessor. "It is established," we are told, "upon a firmer and, in many respects, a much more durable rock; it will be less exposed to the terrible action of the sea; it will be nearly double the height—that is, a hundred and thirty as against the seventy-two feet of the present tower; and it is being constructed on a principle of dovetailing which will insure it against all the worst fury of the waves, even should they exceed the enormous power lately registered at the Skerryvore Rock, which equaled a pressure of three tons to the square foot."—*Illustrated London News.*

## ON THE DIRECT PROCESS OF MAKING WROUGHT IRON AND STEEL.*

By CHARLES M. DUPUY, C.E.,
Philadelphia.

ABOUT one year ago I had the honor of addressing this Institute on the direct manufacture of iron from the ore. I then briefly referred to the various efforts that had been made in that direction, reaching over the best part of the past century, and closed the paper by describing a method, which, from various experimental and practical tests, seemed likely to promise usefulness in the arts.

It may be remembered, by this process the ore, carbonaceous matter and fluxes, in the proper proportions, are ground together and mixed at the same time, and then filled into annular sheet iron cases, holding from 100 to 200 pounds. Ten to twenty of these cases, with spaces between them, are subjected to the gradually increasing heat of a reverberatory furnace, and in about five hours, on the average, the ore and cases settle down, without work upon them, to about one third their original height, becoming welded into quite compact lumps of iron, interspersed with liquid slag. These metal lumps are either then removed separately from the furnace, or several of them being welded together at the same heat, are forged or squeezed and rolled to "muck bar."

This process differs from all others, and it is exactly the reverse of the forge fire and the blast furnace methods. In *those*, a tuyere conducts a stream of oxygen into close contact with the particles of ore, while in *this* process the moderate heat prevents the combination of phosphorus with the iron, while atmospheric contact is excluded during reduction, and a reflected heat from the roof is furnished, for absorption during the transition to metal. It is to this peculiar treatment that is ascribed the high quality of the iron for steel purposes. It is what may be termed a *baking* process, which is conducted at a comparatively moderate heat to *eliminate phosphorus*, and in which the ore is kept out of the reach of oxidizing influences, and to this the high value for steel is attributable.

At the time I addressed you I had licensed Messrs. Miller, Metcalf & Parkin, of Pittsburg, Pa., to work the process at their Crescent Steel Works. Their forge and furnace was not completed until some time in last January, when for several months thereafter they carefully tested the iron which was deoxidized with charcoal by this method, in the various ways customary to determine the value of iron for high grades of steel. The result of these investigations brought forth the unqualified indorsement of this firm that the iron so produced from our native ores, for steel purposes, is equal in every respect to the most costly grades of Swedish iron.

Although the production of fine steel iron, reduced with charcoal by this process, was a step forward, yet the consumption of high grades of steel is comparatively limited, being mostly used only for tools of various kinds requiring great endurance. In order to enlarge the uses of this superior make of iron, it became apparent that its cost must be cheapened by deoxidizing the ore with waste anthracite dust or refuse coke dust, instead of charcoal.

To determine the practical value of anthracite dust, a series of more than fifty experiments were conducted, during the month of August last, at the forge at Reading, Pa. In these experiments with anthracite dust, were used magnetic ore from near West Point, N. Y., Dickinson ore from northern New Jersey, Cornwall ore from Lebanon county, Pa., Cumberland Valley ore from Maryland, hematite ore from near Newark, Del., besides several other ores found near the line of the Philadelphia and Reading Railroad.

These ores were worked both separately and variously combined, and with one exception, in every case were reduced and forged to blooms. The blooms, which were reheated, were drawn out smoothly under the hammer. The tensile strength of one of these bars was tried, and found to not exceed 45,000 pounds to the square inch.

A couple of crucibles of steel were made from a part of the iron which had been reheated and drawn out, and the ingots were forged and used for planing tools. They stood forging and tempering well, comparing favorably in endurance, with steel usually used in planing iron.

The object of testing iron reduced from the ore with *anthracite* coal dust, for tool steel, was not so much with the expectation that at the first trial it would work well in planing iron in competition with steel carefully prepared from *charcoal* iron, but to determine, in a general way, the quality of the metal for steel purposes, of superior quality and in large quantities, by the open hearth. The result of this crucible test surpassed expectations and was very gratifying, from the fact that it is believed to have been the first instance where good tool steel was ever made by a direct process, on a practical scale, from iron deoxidized with *anthracite coal dust*, and confirms the belief that anthracite dust will eventually be largely used to produce steel of high quality, cheaply, and in large quantities.

Besides testing the ores before named, at the Reading forge, iron scale from the rolls (which is almost pure oxide of iron) was reduced alone with anthracite dust, and was also mingled with ore and anthracite, and in both cases it was found to forge well into good blooms.

At the same time with the foregoing experiments, the sulpho-oxides or refuse ore, remaining after extracting sulphur for sulphuric acid from the iron pyrites, at the New Jersey Chemical Works (commonly known to the trade as "Blue Billy"), was also reduced by this process with anthracite coal dust, and forged well into a bloom. This specimen was some time afterward reheated, rolled, cut up and piled with about one third of its weight of muck bar from common puddled iron, and plated out well into smooth sheets of No. 26 iron. This last experiment is not of much value for this country, because very little sulphuric acid is made from pyrites, but in Europe probably not less than a million tons of this refuse ore is now annually almost wasted, because of the difficulty of economically utilizing it.

These Reading experiments were the more gratifying from the fact that the process was quite successfully conducted in a reverberatory furnace, not well adapted to the purpose. This furnace had some time before been specially arranged to test the use of anthracite coal slack, by burning it in fires of four or five inches thickness, on what is commonly termed "the Wooten grate bars." As these thin fires required renewal every fifteen or twenty minutes, the frequent opening of the door for replenishment exposed the ore so often to atmospheric reoxidation, as to make the furnace unsuited to the process. Besides this, the fire and flue bridge walls, which had been constructed very low, and could not be very well raised owing to the lowness of the roof, caused the cases of ore to be exposed to the direct action of the blast and draught as it passed through the furnace into the stack.

Following up these interesting experiments, during the month of September last, a sand bottom scrap-heating furnace was altered at the Sligo Iron Works at Pittsburg, for the purpose of testing this process further, by throwing the lumps of metal into a Burden squeezer, and then rolling them to "muck bar" at the same heat. Hitherto they had usually been forged to blooms under a hammer, and afterward reheated, to be drawn to bars.

This furnace was operated experimentally with 32 heats. There was found no difficulty in making balls to pass through the squeezer and muck rolls at the same heat, just as ordinary puddle balls from pig iron is squeezed and rolled at the same heat to muck bar; but in order to fill the squeezer, which required balls of 150 to 200 pounds to secure a good compression, it became necessary to weld and press several of the lumps of metal together, in the furnace, at a heat so high as to cause the alkali to drip more or less from the mass and soften the sand bottom. As the balls were thus compressed and rolled in the fused sand, an unnecessarily large portion of the iron was thereby cut by the sand, and wasted to a silicate of iron, so that the yield from Republic ore which, before the bottom became softened, produced 53 pounds of iron in muck bar from 100 pounds of ore charged, and which, it was expected, would have been brought up to 60 pounds of iron from 100 pounds of ore, gradually became very much lessened, showing conclusively that reduced yield followed the softening of the bottom, and determined the necessity of a "*cinder-bottom*" in order to save the iron.

To compress and weld several of these masses of metal together in the furnace, in order to have them enter and fill the squeezer, *really comprised all the labor required during the heat.* The cases were 15 inches diameter and 14 inches high, holding about 135 pounds of ore besides the coke and fluxes. By making the cases very little larger, say 16 inches diameter and 16 inches high, they would each produce about 100 pounds of iron, and by withdrawing each separately to the squeezer, all furnace manipulation of the metal would be avoided. Then, aside from maintaining the fire and charging and discharging the metal, all the labor really needed during the heat would be to change the damper once or twice, enabling an ordinary heater to regulate all the furnaces in the largest mill.

The fire or grate surface of this Pittsburg furnace was 4 feet square, and the space between the bridge walls was 9 feet by 5 feet in width. The bottom was of sand, set hard by heat. The flue bridge was built up within 3 inches of the roof. The stack was 18 inches square inside. A fan blast was used, part of the air passing under the grate bars, and parted, being heated, was passed through and over the fire bridge.

In the several experiments it was found that although the opening between the flue bridge and roof for the escape of the spent products of combustion, into the stack was lessened more than one half the size from what it was, when, with less capacity, the furnace had been used for heating scrap iron, still the heat was so intense as to soften and render useless the damper rod at the top of the stack, which had previously stood 12 years, requiring renewal three times during these experiments. The conclusion drawn from these accidents, was that the grate surface of this furnace was amply sufficient to supply the accumulating heat for a length of 14 or 15 feet between the bridge walls instead of 9 feet, thereby nearly doubling the capacity of the furnace with the same consumption of fuel.

Expensive fluxes, such as soda, manganese, etc., have been abandoned, as it has been now conclusively proved that a proper mixture of aluminous and silicious ores with lime, to produce a non-flowing glassy slag, is all that is required. This glassy slag being mingled among the particles of ore, covers and seals them from reoxidation from furnace heat during the process of reduction. When either of these glass making constituents are not available, in the proper proportion, in the ore, ordinary sand or clay, in the proper proportions, may be added to the lime and mixed together without injury to the metal, as the glass is readily compressed out of the iron by the hammer or squeezer.

During these experiments, No. 26 sheet iron was rolled out at the mill from common puddle bar, being found to answer *equally as well for cases* as well finished sheets from the best iron.

It has now been demonstrated that good steel can be made by this process from iron deoxidized either with *charcoal, anthracite dust* or *coke dust.* The carbon in all these fuels being alike, and as the ash of either, along with the earthy impurities of the ore, be they more or less, may be readily reduced to a glass, by a proper mixture of lime and ores, through chemical analysis, and so utilized as a covering of the metal during deoxidation, and compressed from it afterward—it follows the truest commercial economy is found in using that form of carbon which is of least value.

In the coke-making bituminous regions the refuse coke dust is disposed of in waste heaps and often burnt; while from the beginning of anthracite mining, mountains of anthracite slack remain standing monuments of our wastefulness. These wasted fuels, by this process, offer a premium for the production of cheap steel.

Any process that will not withstand the closest economic scrutiny, is justly recognized as valueless in the arts; it is therefore proper to remark, that the investigations at Reading and Pittsburg during the past year, although conducted in furnaces not specially adapted to the process, and often amid inconveniences inseparable from experiments surrounded by the activity of regular mill work, still nevertheless substantially confirm the view heretofore asserted, that a true commercial economy cannot fail to result from a systematic working of the process.

When it is considered that this mode of making iron *frees it almost entirely from phosphorus,* which goes almost altogether into the slag, as explained in my former paper;

That a furnace at present prices for material and labor, in which from one to one and a half tons of blooms may be produced every 24 hours, will not cost over $800 to $1,000;

That a little lime in combination with ore and waste coal slack has been substituted for more expensive fluxes, and is found sufficient to supply the glassy covering for the metal;

That No. 26 sheet iron for cases is now found to be good enough *when plated out from common puddle bar,* and that the cases are very simply and cheaply made, needing neither tops nor bottoms;

That two men, in 10 hours, with a 15 horse-power engine, will grind, mix, and fill the cases with the ore mixture for 7 tons of blooms;

That the furnace work is confined to charging, discharging and firing the furnace, *there being no necessity whatever for manipulating the metal from the time it is charged in the furnace until brought to the hammer or squeezer,* thus greatly simplifying and cheapening what by the puddling process is excessively laborious and expensive work;

That the masses of metal, as one by one they are squeezed to blooms, may then be transferred in the heated state, to the open-hearth bath, and there quickly melted along with the other steel-making material for the highest quality of steel:

When all these points are well considered, it may be clearly understood that in localities as favorably situated—for instance, as the line of the Philadelphia and Reading Railroad, where Cornwall and other ores can be laid down at an average of $3 per ton, and where anthracite fuel and coal dust may be obtained proportionally low—blooms on a large practical working scale, nearly freed from phosphorus, may be manufactured equally as good for $18 or $20 per ton as now cost from $38 to $50 per ton. Similarly great inducements are likewise offered in Northern New Jersey, where fuel and ore can be brought together at about the same cost. In the bituminous coal region fuel is correspondingly low, and coke dust can be had for the freight, offering favorable manufacturing advantages.

In a few words, this process offers a cheap mode of making a high quality of metal for steel, by an inexpensive plant, enabling manufacturers to utilize idle rolling mills at trifling cost.

* A paper read before the meeting of the Franklin Institute, Nov. 20th, 1878.

## COMPARATIVE WEAR OF IRON AND STEEL RAILS.

NEAR Oberthausen, on the line from Cologne to Minden, a variety of rails were laid in 1864, and taken up in 1876. The traffic was very great, and the percentage of replacement in twelve years was as follows: Wrought iron rails, from the Frederich-Wilhelm works, 80·66; wrought iron, from Phœnix works, 68·00; puddled steel, of Funke & Co., 33·33; puddled steel, of Hosch & Sons, 33·33; Hosch & Sons' Bessemer, 4·70; Krupp's Bessemer, 4·08; Hörder-Verein Bessemer, 1·33.—*Annales Industr.*

THE number of vessels that passed through the Suez Canal during the first four months of 1878 was 620; as compared with the corresponding period of the two preceding years, 1877 and 1876, this is an increase of 7 and 44 respectively.

## PARIAN WARE AT THE PARIS EXHIBITION.

PARIAN WARE was first manufactured in Stoke upon Trent in 1848. It is porcelain strongly mixed with feldspar, which holds the mean between English stoneware and vitreous porcelain, and is intended to imitate the Parian statuary marble. It is of a very soft yellowish tint, the surface of a WAX-like luster, showing warm reflections of light and color, with semi-transparent contours, which excellent properties render the material particularly suitable for representations of figure subjects.

The decorative process of rilievo pottery, *pate sur pate*, has come into great favor and been very much perfected lately in England. There are many varieties, among which we distinguish the well-known cameo ware showing white figures on colored glazed ground. After manufacturing the body, raised ornaments or figures are applied on the unburnt colored ground by washing the white uncolored paste in water, and laying it, by means of the panel brush, in thin coats on the enameled surface. The white rilievo work is then frisé by burning, the raised opaque parts of the paste representing the light, the thinner and more transparent parts the shade of the ornament. Draped figures, garlands, and other decorative features seem translucent in strong light, and appear in softly reflected tints of the colored ground.

The body of the vase, here shown, is sea-green, the Roman scrolls, frets, and lineal ornaments in gold and silver, the frieze with amorini on blue ground, the supporting figures of foot in silver with drapery in gold.

We give this work as one of the most remarkable objects by which the well renowned house of Minton & Co., Stoke upon Trent, was represented at the Paris Exhibition. Height of vase 37 inches by 18 inches in width.—*The Workshop.*

THE PARIS EXHIBITION.—PARIAN VASE, PAINTED BY SOLON. MANUFACTURED BY MINTON & CO.

PEOPLE seem to think that the earth of a farm is capable of oxidizing and destroying any quantity of sewage or drainage containing dissolved organized matter. But all soils have a district limit in this respect, which cannot be exceeded with safety. The assimilation of putrescible substances by plants is a matter of time, and until that work is fully completed the juices of the vegetation are offensive to the smell. Cows fed upon sewage grass have been known to yield milk which is very different from that which they give when they are fed with sweet grass.

## THE CARR DISINTEGRATING FLOUR MILL.

THE disintegrator was the creation of Mr. Carr's genius (Mr. Thomas Carr, of Bristol, Eng.), and its improvement, from its invention in 1859, was a task to which he devoted the best energies of his life. Its application to the purposes of a flour mill was a development of his original idea, which long seemed an impossibility to himself. How could a material like wheat, which is entirely destitute of anything to serve as an abutment, which was invariably provided in any kind of flour mill, to be pulverized by percussion while flying through the air? It was not deemed possible that wheat, with its low specific gravity, the minuteness of its particles, and the tough and fibrous nature of its outer covering—the bran—could, by its mere *vis inertia* present sufficient resistance to beaters to enable them to reduce it into flour while it was unsupported and flying freely through space. This seeming impossibility, however, was made possible, and a machine which had been invented for the treatment of such gross materials as ores, minerals, clays, and manures, was, so to speak, sublimated by the mechanical genius of its inventor into a machine for the manufacture of the exquisitely delicate material of which our daily bread is composed. Had Mr. Carr lived longer, it is quite possible that several questions connected with his machine which still wait for solution, would have been solved, but the inventor died in 1874, and the further improvement of his invention, if improvement there was to be made, was left for other hands. Mr. Philip Triggs, Bristol, and Mr. Benson, solicitor, of the same city, were appointed Mr. Carr's trustees by the will of that gentlemen, Mr. Triggs being invested with the management of the patent. Prior to Mr. Carr's demise, he assigned his patents in France and Belgium to M. Toufflin, 25 Rue de Constantinople, Paris. Subsequently Mr. Carr's trustees entered into further arrangements affecting the countries just named with M. Toufflin.

The disintegrator flour mill of both sizes, viz., 7 feet and 5 feet diameter, respectively, were adopted by some millers in the United Kingdom. It took a large amount of courage to adopt a novelty of such an extreme and even startling stamp as that which Mr. Carr had provided, and great credit was due to those gentlemen who had the intelligence to perceive that, in the means of a revolution in the mode of flour manufacture that had been effected by Mr. Carr, there was at least something that was worthy of a practical investigation.

We come now to a description of the Carr-Toufflin Disintegrating Flour Mill, exhibited at the Paris Exhibition, and which is the subject of the patent, 9th February, 1878, No. 546. No further description of the general principles and mechanism of the machine is required than we have given above; all that is now necessary is to explain the engravings of the machines on the next page, which we shall do in the patentee's language. Fig. 1 is partly a longitudinal section and partly the elevation.

Two shafts, B, B′, are employed, placed end to end, supported on frames, A, A′, and rotating in opposite directions in bearings, C, C′, of peculiar construction, enabling the shafts to be regularly and constantly lubricated, even when rotating at high rates of speed. The ends of the shafts, which are in juxtaposition, carry disks, D, D, upon which the cages or beaters, *d*, *d*, are fixed in concentric rows rotating in a case, E, strengthened externally by angle irons and made to fit as closely as possible over the said disks. The shafts are passed through stuffing boxes, *e*, *e*′, in the side of the case.

The shafts are driven by pulleys, F, F′, which are keyed upon them and caused to rotate in opposite directions by a belt carried over the main driving shaft.

The case E, is connected to a hopper, L, for containing the substance to be treated by means of a tube, G, bifurcated at the end within the case, so as to deliver the substance at the center of the cage, and provided with an apparatus for excluding air at the other end where it is connected to the hopper. This apparatus consists of a cylinder, H, divided into several approximately air-tight compartments by radial portions, M, attached to a shaft passed through the center of the cylinder, and caused to rotate by a pulley, O, driven by a belt connected to the main driving shaft.

As each compartment is presented in turn to the aperture at the bottom of the hopper, L, it is filled with the grain or other substance to be pulverized or reduced, and as it continues to rotate it carries the same round to the aperture on the top of the feed pipe, G, into which its contents are discharged, while all air except that which is contained in the interstices of the grains or granules is effectually excluded.

A similar arrrangement is provided for the discharge of the flour or pulverized substance through a pipe, *i*, at the lower part of the case for excluding air at this point, this apparatus being likewise actuated by a belt and pulley, O′, Fig. 2, driven by the main driving shaft.

A more or less perfect vacuum is maintained within the case by means of a pump, J. Fig. 2, on what is known as Greindl's system, connected to the case by a pipe, *j*, and actuated by the main driving shaft; or an ejector, K, Fig. 2, provided with a check valve may be employed for effecting the same object by means of a jet of steam obtained either direct from the boiler or from the exhaust pipe of the engine.

The air within the case being continually exhausted and rarefied by the action of the Greindl pump or ejector, the injurious resistance hereinbefore referred to is considerably reduced, if not completely obviated.

It is evident that air may be exhausted from the chamber in which the cages rotate by means of apparatus other than those hereinbefore specified, such for example as ordinary air pumps; the air may also be exhausted through hollow shafts, or the outlet or outlets for the air may be situated at any part of the case which may be found most convenient according to circumstances, and the said outlets may be provided with wire gauge diaphragms, as shown at *A*, *A*, Fig. 2, in a conical chamber which will not impede the passage of the air, while the wire gauge prevents the escape of the flour, and for the same purpose the pipe through which the air is exhausted may be made of a siphon form, as shown in dotted lines at *l*, *l*, Fig. 2, or the apparatus described for the discharge of the flour may be replaced by a powerful fan, exhausting the air within the case, and delivering the flour to a bolting apparatus, which will thus be enabled to work easily and economically under pressure.

This improved pulverizing or disintegrating apparatus working in a rarefied atmosphere possesses other important advantages besides the great saving in motive power. The rarefaction or exhaustion of the air in the chamber in which the cages work has the effect of considerably reducing the temperature in the said chamber, and maintaining it at a very low degree, which, in the production of flour or meal in general, and corn or wheat and flour in particular, is a most

important object. This rarefaction or exhaustion of the air also has the effect of facilitating the free fall or projection of the grains or granules, also of promoting the evaporation of the water contained in the grain, so as to greatly facilitate its decortication.

Moreover, this last-named effect of the rarefaction or exhaustion of the air enables dry meal or flour to be obtained direct from the mill, and consequently in the best possible condition for its transport or preservation.

The said invention is applicable to disintegrators generally constructed upon the principle of that hereinbefore described and illustrated in the accompanying drawings, whether with vertical or horizontal axes, either solid or hollow, and with any required modifications in the details of construction.

Having now described and particularly ascertained the nature of the said invention, and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that what I consider to be novel and original, and therefore claim as the invention secured to me by the hereinbefore in part recited letters patent, is, reducing grain and other substances in a vacuum or partial vacuum, substantially in the manner and by the means hereinbefore described.

Such is the description of the form of the machine shown at the Paris Exhibition, and which has attracted a very large share of attention from visitors and experts. The disks of the Toufflin machine are one meter (about 40 inches) diameter, the diameter of the beaters being about half an inch, and three-fourths of an inch long, arranged in circles about one inch apart; from one beater to another is about one centimeter (four-tenths of an inch). The orifice of the feed pipe is about four inches diameter, and the speed is 1,153 revolutions per minute. The chief practical questions that remain to be solved are the driving power of the machine and its quantitative results. With regard to the first, there are various statements, but so far as can be judged from the conflicting estimates, the power is greater than that required for millstones. On the other hand, the advocates of the system say that, supposing the power to be slightly in excess of that required of millstones, the disintegrator still has economic advantages, because the cost of millstone dressing is dispensed with, and the flour produced is superior in quality. From personal observation we are prepared to admit that a certain quantity of the flour

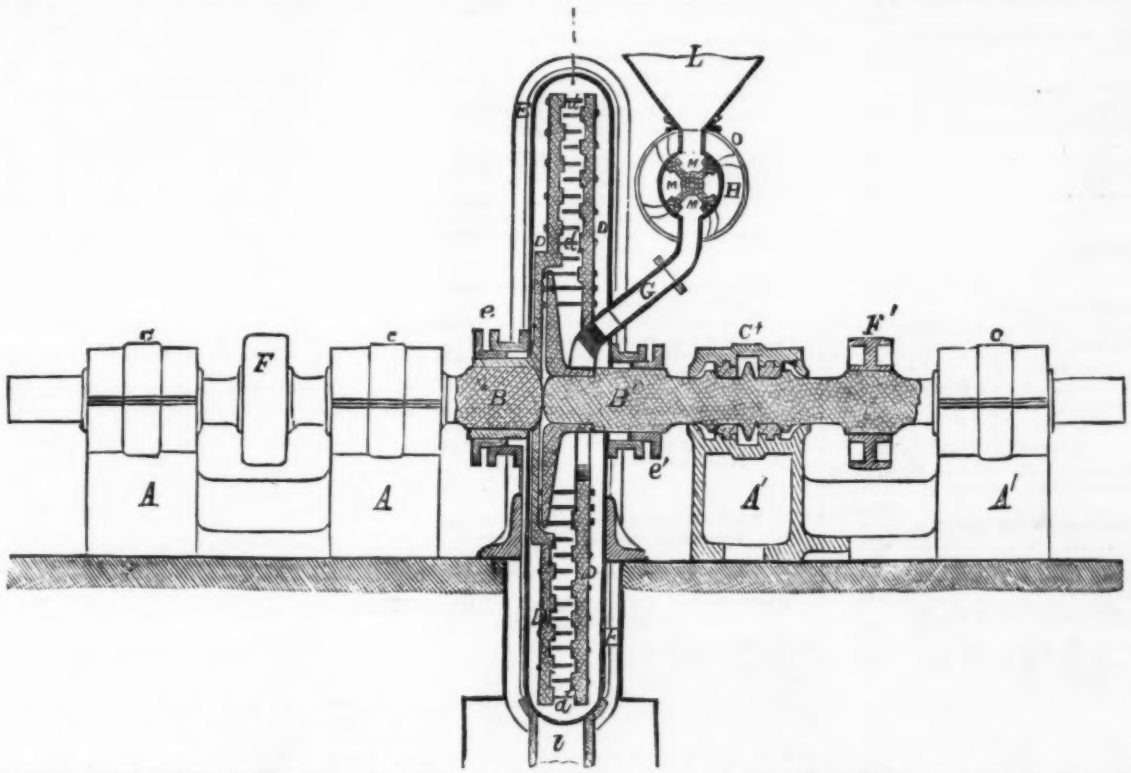



FIG. 1.—CARR-TOUFFLIN DISINTEGRATING FLOUR MILL.—PART SECTION AND PART ELEVATION.

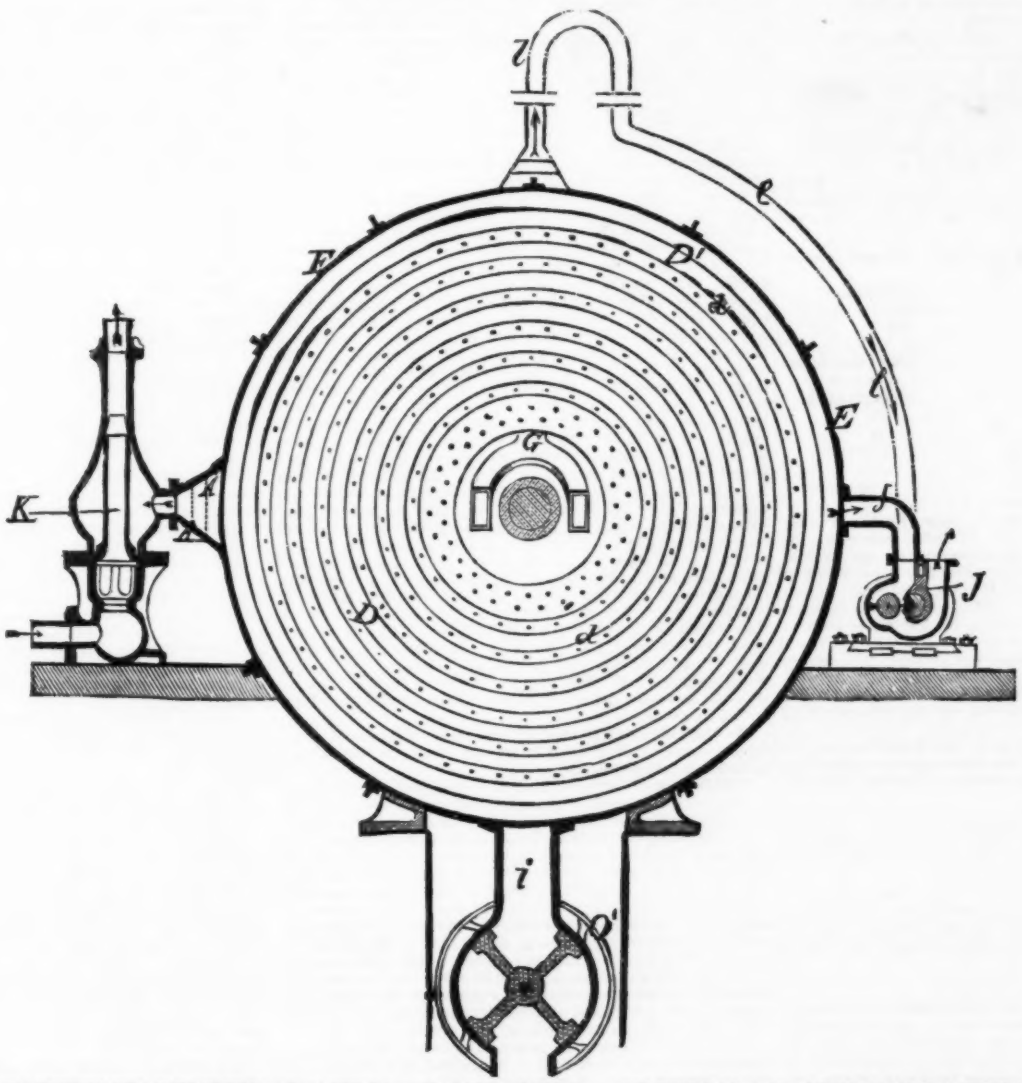



FIG. 2.—CARR-TOUFFLIN DISINTEGRATING FLOUR MILL.—SECTION SHOWING BEATERS OF DISK, &c.

produced is of a very excellent grade, but we were unable to ascertain, on independent grounds, the exact percentage of flour to wheat produced. The following statement which we have received is the nearest approach to exactitude we have obtained:

CHARONNE, February 13th, 1877

RESULT OF BOLTING 1,044 KILOS (1 KILO = 2 LBS 3 OZS.) OF MEAL FROM FRENCH WHEAT. (HIGH GRINDING.)

| | kilos. |
|---|---|
| First quality of flour, dressed through French silks, Nos. 150 to 180 | 434 |
| Semolina, soft | 140 |
| " hard, dressed through French silk, Nos. from 55 to 100 | 318 |
| Reground middlings, dressed through No. 50 French silk | 34 |
| Small bran, through No. 45 | 46 |
| Middlings bran, through No. 40 | 18 |
| Large bran, from tail of silk | 79 |
| | 1,069 |
| Tare of 25 sacks, etc., say | 25 |
| | 1,044 |

Rate of production, 2,000 kilos per hour.
Diameter of machine, 70 centimeters (28 inches). Width, about 4 centimeters (1·6 inch).

SUMMARY.

| | |
|---|---|
| Fine flour | 43 parts per 100 |
| Semolina | 45 " " |
| Bran | 12 " " |

CHARONNE, February 14th, 1877.

RESULT OF BOLTING 868 KILOS (1,750 LBS.) OF MEAL FROM FRENCH WHEAT. (LOW GRINDING.)

| | kilos. |
|---|---|
| Fine flour, dressed through French silks, Nos. 150 to 180 | 479 |
| Semolina, soft | 68 |
| " hard, dressed through French silk, Nos. 55 to 100 | 208 |
| Re-ground middlings, dressed through No. 50, French silk | 23 |
| Small bran, through No. 45 French silk | 34 |
| Middlings bran, through No. 40 French silk | 14 |
| Large bran, from tail of silks | 57 |
| | 883 |
| Tare of 15 sacks, etc., say | 15 |
| | 868 |

Rate of production, 1,000 kilos per hour.
Diameter of machine, 70 centimeters (28 inches). Width about 4 centimeters (1·6 inch).

SUMMARY.

| | |
|---|---|
| Fine flour | 54¼ parts per 100 |
| Semolina | 33½ " " |
| Bran | 12 " " |

RICE EXPERIMENT.—NOTES OF AN EXPERIMENT ON 1,000 KILOS OF BROKEN RICE AT CHARONNE, OCTOBER 1, 1878.

Diameter of machine, 1 meter (40 inches).
Length of beaters, 16 millimeters (0·64 of an inch).
Speed, 1,150 revolutions per minute.
Estimated actual horse power required to drive the disintegrating mill, and requisite dressing machinery, 22 h.-p.

The silks were coarser than was desirable for the experiment, the numbers for flour ranging from 120 to 160, inclusive, and for semolina from 80 to 110. The rice was dealt with by the machine at the rate of about 550 kilos per hour, but it must be noted that the width of the machine between the disks was only 16 millimeters (0·64 of an inch). 200 kilos of rice meal were reserved as a sample of the work done by the machine. The remaining 800 kilos were passed through the dressing machinery, *and the semolina returned to the disintegrator.*

The result as to quantity of rice flour obtained, was as follows:

| | |
|---|---|
| First passage (broken rice) | 365 kilos. |
| Second " (semolina) | 260 |
| Third " " | 99 |
| | 724 of fine flour. |

To this must be added—

| | |
|---|---|
| Weight of samples | 19.50 kilos. |
| Semolina not reduced | 26 |
| Waste from tail of dressing silks | 6 |
| Left in silks, machinery, etc., say | 24.50 |
| | 800 kilos, |

the same not having been cleaned out.

With regard to the quality of the flour, Professor Kick says he compared Toufflin's No. 1 flour, according to Pekar's method, with No. 3 flour, according to the Prague numbers, and *the result was such as would induce no Austrian miller to adopt Toufflin's process.* It may, he thinks, be an improvement on the primitive method of French milling, but it will certainly not be adopted in Austria. Toufflin uses very soft French wheat; with the same kind of treatment, the hard Hungarian wheat would yield still darker flour.

Toufflin's assertion that 200 lbs. of his flour would furnish 300 lbs. of bread, was not borne out by the experience of Professor Kick.

There can be but one opinion as to the ingenious way in which the original inventor of the disintegrator applied his invention to the purposes of a flour mill. Whether, however, the disintegrator, even with all the improvements that have been made upon it, is destined to supersede the millstone and other means for the conversion of wheat into flour, is a question which is in the hands of the future.—*The Miller.*

THE decay of timber in contact with stone can, it is stated, be entirely avoided by the insertion of iron, either as a thin plate or in horseshoe form, between the wood and the stone. The hard crust formed on the wood by its contact with the iron prevents decay.

LUMINOUS watches are now being manufactured at Chaux-de-Fonds, the great watchmaking village of Switzerland. The figures on the watch-dial are submitted to a peculiar process, which renders them phosphorescent and visible in the dark if exposed for a few moments each day to the sunlight.

## A STORY OF SCIENCE.

BY ONE WHO KNOWS NOTHING ABOUT IT.

A philosopher sat in his easy chair,
Looking as grave as Milton;
He wore a solemn and mystic air
As he Canada balsam spilt on
A strip of glass, as a slide to prepare
For a mite taken out of his Stilton.

He took his microscope out of his case,
And set the focus rightly:
The light thrown back from the mirror's face
Came glimmering upward brightly.
He put the slide with the mite in place,
And fixed on the cover tightly.

He turned the instrument up and down,
Till getting a proper sight, he
Exclaimed—as he gazed with a puzzled frown—
"Good gracious!" and "Highty-tighty!
The sight is enough to alarm the town—
A mite is a monster mighty!"

From t'other end of the tube, the mite
Regarded our scientific—
To its naked eye, as you'll guess, the sight
Of a man was most terrific:
But reversing the microscope, made him quite
The opposite of magnific.

"One sees the truth through this tube so tall,"
Said the mite as he squinted through it;
"Man is not so wondrously big after all,
If the mite-world only knew it!"

MORAL.

MEM.—Whether a thing is large or small
Depends on the way you view it.

—*Fun.*

## HISTORY OF THE AMERICAN LEAD PENCIL MANUFACTURE.

*To the Editor of the Scientific American:*

On reading over an article in *Scribner's Magazine*, of April, 1878, entitled "How Lead Pencils are Made," it has occurred to me that some account of their earliest manufacture in this country might be of sufficient interest to justify publication in your valuable journal, where one expects to find the records of all inventions and discoveries, both past and present.

The article in *Scribner's* might lead the reader to suppose that Mr. Dixon, in his experiments in Salem, in 1830, was the pioneer, or the first maker of pencils in America. Mr. DIXON probably made no such claims, for he must have known that there was, at that time, at least one manufacturer of the article in Massachusetts, whose name and reputation were well known by every school boy and girl in the country. Wm. Monroe's pencils, or "Monroe's pencils," as they were universally called, were as familiar to the public as "Faber's pencils" are at present. But to the early history:

At the commencement of the war of 1812, Wm. Monroe was a young cabinetmaker in Concord, Massachusetts. Non-intercourse, non-importation, and the embargo laws had depressed nearly all kinds of business, among others that in which Mr. Monroe was engaged. The demand for articles that hitherto had only been made abroad was, however, an exception; for those non-importation created a scarcity, consequently invention in that direction was encouraged and rewarded. This, then, was his field. Seeing what a high price had to be paid for a lead pencil, and that the article could hardly be procured at all, he determined to see what he could do toward making them.

He acted on the idea at once, and procured a few lumps of black lead. This he pulverized with a hammer, and separated the finer portions by their suspension in water in a tumbler. From this he made his first experimental mixture in a spoon, and from this was his first attempt to make a pencil. The result was not very encouraging. He continued his cabinet work, making a few cabinetmakers' squares (an article previous to that time not made in this country), but his mind was principally occupied for two or three months in devising ways of making pencils, having access to no information that could assist him, fearing to consult his friends on the subject, and sometimes discouraged by repeated failures. But, finally, securing some better lead, and picking up a little cedar wood from the neighboring hills, he was able, on the 2d of July, 1812, to proceed to Boston with a modest sample of about thirty lead pencils, the first of American make, and naturally of not very good quality. These he sold to Benjamin Andrews, a hardware dealer in Union street, to whom he had sold the cabinetmakers' squares. Mr. Andrews was an active, enterprising man, who encouraged all such novelties, and he advised going on with lead pencils. This advice suited his intentions, and on the 14th of July he went to Boston with three gross of pencils. These also were readily taken by Andrews, who then made a contract, agreeing to take all that should be made up to a certain time at a certain price.

All the mixing of the lead and putting it into pencils was done entirely by his own hands, in a small room of his dwelling house, thoroughly protected from curious eyes, no one but his wife being permitted to know anything of his secret methods.

He continued pencil making for about eighteen months, when, owing to the great difficulty of obtaining black lead, it had to be set aside.

Looking about for something else worthy his attention, he commenced the making of tooth brushes and watchmakers' brushes, which were also, I believe, the first made in America.

At the close of the war, being again able to procure the necessary materials, he made a few lead pencils, but the importation of a better article seriously interfered with him, and he began to think he should make nothing further in that business. He did not, however, forget nor neglect the subject, but with greater facilities of obtaining information, and by continued experiments, he continued occasionally to make a few pencils for sale in addition to his cabinetmaking business. This continued till 1819, when, having prepared himself with better experimental results, and obtaining better materials, he abandoned all other business, and devoted himself solely to the manufacture of lead pencils.

It was not without a struggle that his reputation as a manufacturer was established and recognized, and not till after more than ten years of persistency and study in improving their quality that he was able to say that purchasers were a length as ready to seek him as he had hitherto been to seek them.

From that time, so long as he was in business, he stood before the public as the best and principal maker of lead pencils in this country, as he had been the first, supplying a large part of the demand for that article.

The popularity of Monroe's pencils induced several unprincipled men to counterfeit his stamps and labels, and at least two small manufacturers in Massachusetts were guilty of ascertaining and appropriating by unworthy means his secrets of manufacturing. One merchant in New York imported a large lot of German pencils with W. Monroe's name boldly stamped upon them. For this smart operation one of Mr. Monroe's sons compelled a confiscation and destruction of the pencils, and a fine of five hundred dollars.

Mr. Monroe's method of making pencils was quite different from that adopted at present. The lead was mixed with other ingredients (which were his secret) into a sort of paste, and in this soft state was worked into the grooved board, and when dry manipulated into a proper degree of solidity, and then the pencils were finished.

In addition to pencils, Mr. Monroe manufactured also quite extensively ever-pointed-pencil leads, which were as popular in their way as were his pencils. * *

## INKS.

*Black Ink.*—Bruised Aleppo nut galls, 2 lbs.; water, 1 gallon; boil in a copper vessel for an hour, adding water to make up for that lost by evaporation; strain and again boil the galls with a gallon of water and strain; mix the liquors and add immediately 10 ozs. of copperas in coarse powder and 8 ozs. of gum arabic; agitate until solution of these latter is effected, add a few drops of a solution of potassium permanganate, strain through a piece of hair cloth, and after permitting it to settle, bottle. The addition of a little extract of logwood will render the ink blacker when first written with. Half an ounce of sugar to the gallon will render it a good copying ink.

*Aniline Black Ink.*—Concentrated solution of borax 1 part, shellac 4 parts; boil; add aniline black.

*Black Ink.*—Shellac 4 ozs., borax 2 ozs., water 1 qt.; boil till dissolved, and add 2 ozs. gum arabic dissolved in a little hot water; boil and add enough of a well triturated mixture of equal parts of indigo and lamp-black to produce the proper color; after standing several hours draw off and bottle.

*Asiatic Black Ink.*—Logwood shavings and powdered galls, of each 2 pounds, green vitriol 1 pound, gum ½ pound, pomegranate bark ¼ pound, water 1 gallon; infuse 14 days with frequent agitation, or boil.

*Runge's Black Writing Fluid.*—Digest ¼ pound logwood in fine chips for 12 hours in 3 pints boiling water, then simmer down gently to 1 quart, carefully avoiding dust, grease and smoke. When cold decant the decoction and dissolve in it by agitation 20 grains yellow chromate of potash; it will then be fit for use.

*Arnold's Writing Fluid.*—This writing fluid is a mixture of sulphate of indigo and ordinary ink. It flows freely from the pen, and at last becomes very black.

*Green Ink.*—Dissolve 180 grains bichromate of potassa in 1 fluid ounce of water, add while warm ½ ounce spirit of wine, then decompose the mixture with concentrated sulphuric acid until it assumes a brown color; evaporate this liquor until its quantity is reduced to one half, dilute it with 2 ounces distilled water; filter it, add ½ ounce alcohol, followed by a few drops of strong sulphuric acid; it is now allowed to rest, and after a time assumes a beautiful green color. Add a small quantity of gum arabic and it is ready for use.

*Beautiful Blue Writing Fluid.*—Dissolve basic or soluble Prussian blue in pure water. This is the most permanent and beautiful ink known.

*Brilliant Red Ink.*—Brazil wood 2 ounces, muriate of tin ½ drachm, gum arabic 1 drachm; boil down in 32 ounces water to one half, and strain.

*Buchner's Carmine Ink.*—Pure carmine 12 grains, water of ammonia 3 ounces; dissolve, then add powdered gum 18 grains; ¼ drachm of powdered drop lake may be substituted for the carmine where expense is an object.

*Violet Copying Ink.*—For blue violet, dissolve in 300 parts of boiling water methyl violet 5B, Hofmann violet 3B, or gentiana violet B. For reddish violet, dissolve in a similar quantity of water methyl-violet BR. A small quantity of sugar added to these inks improves their copying qualities. If the writing, when dry, retains a bronzy appearance, more water must be added.

*Red Ink.*—Half a drachm of powdered drop lake and 18 grains of powdered gum arabic, dissolved in 3 ounces of ammonia water, makes one of the finest red or carmine inks.

*White Ink.*—Mix pure freshly precipitated barium sulphate, or "flake white," with water containing enough gum arabic to prevent the immediate settling of the substance. Starch or magnesium carbonate may be used in a similar way. They must be reduced to impalpable powders.

*Indelible Ink for Marking Linen.*—Add caustic alkali to a saturated solution of cuprous chloride until no further precipitate forms; allow the precipitate to settle, draw off the supernatant liquid with a siphon, and dissolve the hydrated copper oxide in the smallest quantity of ammonia. It may be mixed with about 6 per cent. of gum dextrin for use.

*Another.*—Asphaltum 1 part; oil of turpentine 4 parts; dissolve and temper with printer's ink. Best used with a stamp.

*Marking Ink for Linen, &c.*—Dissolve shellac in a little water by boiling it with about 1-6 part of borax, and add to this solution a sufficient quantity of nigrosine to produce the proper color.

*Carbon Ink.*—Genuine India ink rubbed down with good black ink until it will flow easily from a pen. This ink resists chlorine and oxalic acid.

*India Ink.*—Purify fine lampblack by washing it with a solution of caustic soda, dry, and make into a thick paste with a weak solution of gelatine, containing a few drops of musk essence and about half as much ambergris; mould and dry. Instead of gelatine the following solution may be used: seed lac 1 oz., borax ¼ oz., water 1 pint; boil until a solution is effected, and make up with water to ¾ pint.

*Japan Ink.*—Dissolve in half pint of soft water ⅜ oz. of potassium bichromate, and add the solution to 6 ozs. of logwood extract, dissolved in one gallon of water; then dissolve in one gallon of water by continued boiling, borax 6 ozs., shellac 1½ ozs. Mix all together while warm and add 3 ozs. of ammonia.

*Ink Powder.*—1 pound nut galls, 7 ounces copperas and 7 ounces gum arabic. Pulverize and mix. This amount of ink powder will make 1 gallon of good black ink. Two or

three powdered cloves should be mixed with each pound of powder to prevent moulding.

*Gold Ink.*—Honey and gold leaf equal parts; triturate until the gold is reduced to the finest possible state of division, agitate with 30 parts of hot water, and allow it to settle. Decant the water and repeat the washing several times; finally dry the gold and mix it with a little weak gum water for use.

*Silver Ink.*—For silver ink the process is the same as for gold, substituting silver leaf for the gold leaf.

*Ink for Marking Packages.*—Take lampblack and mix thoroughly with sufficient turpentine to make it thin enough to flow from the brush. Powdered ultramarine, instead of lampblack, makes a fine blue marking mixture for the same purpose.

*Ink for Marking Packages.*—An excellent and very cheap ink is made by mixing ¼ ounce of bichromate of potassa and 4 ounces of extract of logwood in a stone jar or demijohn with 2 gallons of hot water. Shake well and let it stand for about two weeks, shaking occasionally.

*Purple Marking Ink.*—A purple marking ink can be prepared by mixing 1 part bichloride of platinum with 16 parts distilled water. The place where the letters have to be written must be moistened with a solution of 3 parts carbonate of soda, 3 parts gum arabic, and 12 parts of water. The spot is then dried and made smooth. After the letters have been written with platinum ink and become dry, the linen is moistened with a solution of 1 part chloride of tin in 4 parts distilled water, when an intense and beautiful purple-red color makes its appearance.

*Ink for Marking Textile Fabrics.*—Triturate 4 parts of powdered soluble nigrosine in about 15 parts of hot water, and strain the hot solution repeatedly through fine silk, or filter it through filter paper, using a hot funnel.

*Sympathetic Ink.*—Write with a solution of ferrocyanide of potassium; develop by pressing over the dry invisible characters a piece of blotting paper moistened with a solution of copper sulphate or of copperas.

*Another.*—Write with pure dilute tincture of iron; develop with a blotter moistened with strong tea.

*Black Sympathetic Inks.*—A weak infusion of galls is turned black by sulphate of iron (copperas).

Reversing the above, writing with copperas turns black by moistening with infusion of galls.

*Blue Sympathetic Inks.*—Writing with copperas turns blue if wetted with a solution of prussiate of potassa.

Nitrate of cobalt turns blue on being wetted with a weak solution of oxalic acid.

Rice water or a solution of boiled starch turns blue in a solution of iodine in weak spirit.

*Sympathetic Inks Developed by Heat.*—There are a number of colorless substances that may be used as inks which are developed by the application of heat only.

Sulphate of copper and sal ammoniac, mixed in equal parts, will become yellow if exposed to the fire.

Onion juice has the same property as the above mixture.

Lemon juice, a very weak solution of either aqua fortis, oil of vitriol, common salt, or saltpeter, will turn yellow or brown on exposure to the fire.

A weak solution of chloride of cobalt and chloride of nickel is turned a beautiful green by heat.

A solution of chloride, or nitro-muriate of cobalt turns green when heated, and disappears again on cooling.

A dilute solution of chloride of copper becomes a fine yellow at a moderate heat, and disappears on cooling.

A solution of acetate of cobalt, with a little nitrate added to it, turns rose-colored by heat, and disappears again when cold.

These last, which disappear again on cooling, are the best sympathetic inks for purposes of correspondence, as the others are more or less indelible when once developed.

*Drawing Ink.*—A very black and indelible drawing ink may be made by dissolving shellac in a hot water solution of borax, and rubbing up in this solution a fine quality of India ink. After using, dip the drawing pen in alcohol and wipe dry, to keep it clean and bright.

*Hausmann's Indestructible Ink.*—Mix 1 part genuine Trinidad asphaltum with 4 parts oil of turpentine; color with a sufficiency of plumbago for black, or vermilion for red, ink.

*Close's Indestructible Ink.*—Mix 25 grains powdered cobalt and 200 grains oil of lavender by a gentle heat; color with 3 grains lampblack and 1 grain indigo, both in fine powder. If a red color is required, omit the lampblack and indigo, and add sufficient vermilion to make the mixture a good color.

*Shoemaker's Ink.*—Dissolve an equal quantity each of copperas and gum arabic in a small quantity of boiling water, and add a very little extract of logwood to the solution. If it gums, dilute it a little with hot water Concentrated solution of shellac in hot aqueous solution of borax is sometimes used in place of a portion of the gum.

*Colored Stencil Ink.*—Shellac 4 parts, borax 1 part; dissolve in a small quantity of boiling water and dilute with hot water to the consistency of very thin syrup; to this add a sufficient quantity of logwood, or Brazil wood extract, or soluble coal tar reds, for red. For blue add to the lac solution soluble Prussian blue, or blue carmine.

*Pyrograph Ink.*—Dissolve any of the soluble dyes in warm glycerine.

*Ink for Zinc Labels.*—Take 1 drachm of verdigris, 1 drachm sal-ammoniac powder and ½ drachm lampblack, and mix them with 10 drachms water. This will form an indelible ink for writing on zinc.

*Permanent Ink for Writing in Relief on Zinc.*—Bichloride of platinum, dry, 1 part, gum arabic 1 part, distilled water 10 parts. The letters traced upon zinc with this solution turn black immediately. The black characters resist the action of weak acids or of rain, and the liquid is thus adapted for marking signs, labels, or tags which are liable to exposure. To bring out the letters in relief, immerse the zinc tag in a weak acid for a few minutes. The writing is not attacked, while the metal is dissolved away.

*To Write on Silver with a Black that will Never Go Off.*—Take burnt lead and pulverize it. Incorporate it next with sulphur and vinegar to the consistency of a paint, and write with it on any silver plate. Let it dry, then present it to the fire so as to heat the work a little, and it is completed.

*Ink; To Prevent from Souring.*—Add a few drops of carbolic acid and clove oil to each pint bottle.

*Ink Eraser.*—Cold aqueous or acetic acid solution of calcium hypochlorite, bleaching powder or Eau de Javelle.

## ON M. A. GAUTHIER'S PROCESS FOR THE DETECTION OF ARSENIC.

PROF. SELMI shows that in this process there may occur loss of arsenious acid. He modifies it as follows: 100 grms. of the suspected matter are heated with 20 grms. of pure nitric acid until reduced to a yellowish pulp. The heat is then withdrawn, and 5 grms. of sulphuric acid are added. The mixture is heated again till white fumes begin to escape, when 10 to 12 grms. more of nitric acid are added, and heat is applied till a small portion gives with boiling water a dark yellow liquid. It is then filtered, washed repeatedly to insure complete exhaustion, the liquid evaporated, and the residue taken up repeatedly with hot nitric acid until the solution becomes a light yellow. Sulphurous acid is then added in excess, the liquid is saturated with sulphuretted hydrogen, and left for a day at a luke-warm temperature, taking care that there shall be always an excess of sulphuretted hydrogen. On operating in this manner there is neither loss of arsenious acid during carbonization, nor is any arsenic retained in the organic matter.

## THE ABSORPTION AND REPULSION OF THE CHEMICAL RAYS BY COLORED CARBON SURFACES.

M. PARIS lays down the principle that the time of exposure of emulsified papers must be regulated by the power of absorption or repulsion possessed by the colored surfaces under the influence of light. Regarding it from this point of view, it may be said that two emulsions containing the same quantity of gelatine, but *different amounts* of the same coloring material, are not of the same color; or, in other words, that the two emulsions have not the same power of absorption or repulsion when acted upon by light of the same kind. Thus, let us take two supports of any kind, each measuring five centimeters square; on the one we pour ten cubic centimeters of a five per cent. solution of gelatine containing twenty grammes of Prussian blue, and on the other the same quantity of a similar solution of gelatine containing four grammes of the same coloring material; it will be at once evident that the two films, when dried, are not of the same color, and, consequently, will not reflect to the same extent. This phenomenon is certainly worthy of being attentively studied by practical photographers. In fact, as M. Paris points out, when a piece of emulsified paper is cut for the purpose of placing it in the printing-frame, how is it possible to tell what quantity of coloring material is spread over its surface? This quantity may vary within indefinite limits; even the very persons who have prepared the emulsion would be unable to determine it even approximately. But if it be only a question of finding the chemical value of the colored light reflected by the emulsified paper it will be easy enough. According to M. Paris's view, therefore, it is this chemical value of the reflected light that it is important to measure, and thus arrive at the determination of the actinic action of the rays that print the image through the photographic negative that is interposed like a screen. This problem M. Paris believes he has successfully solved, and he adduces numerous experiments, carried out by himself, which control and confirm his results. He has drawn up the table given below, taking account at the same time of the physical properties and of the actinic coefficient of the colors of the spectrum. Absolute black, though it does not exist in nature, has been taken at the starting-point when there is a *complete absence* of all actinism or *negative reflection;* and absolute white, which also has no real existence, is taken as the other limit of the scale, the *maximum of the chemical action of light*, or *positive reflection.* This table has, therefore, a double reading: it gives for each color of the spectrum the maximum of chemical reflection, and the maximum of the chemical absorption of the luminous rays falling on the colored surface—in a word, the maximum of actinism and the maximum of inertia. It will also be noticed that absolute black is taken as absorbing, and absolute white as reflecting, all the rays of light that fall on the colored surface.

| | Degrees of Absorption. |
|---|---|
| Absolute black, complete inertia, or negative reflection | 100 |
| Relative or natural black | 10 |
| Orange | 87·50 |
| Green | 75 |
| Yellow | 62·50 |
| Red | 50 |
| Indigo | 37·50 |
| Blue | 25 |
| Violet | 12·50 |
| Relative or natural white | 10 |
| Positive reflection | 0 |
| | **Degrees of Repulsion.** |
| Absolute white, complete actinism, or positive reflection | 0 |
| Relative or natural white | 10 |
| Violet | 12·50 |
| Blue | 25 |
| Indigo | 37·50 |
| Red | 50 |
| Yellow | 62·50 |
| Green | 75 |
| Orange | 87·50 |
| Relative or natural black | 90 |
| Negative reflection | 100 |

As will be seen by casting a glance over this table, all the degrees of absorption or negative reflections have, as complements, all the degrees of repulsion or positive reflections. For example, yellow, which is given in the table 62·50, has for its complement, indigo, which is given 37·50. By adding—

| | |
|---|---|
| The yellow negative reflection | 62·50 |
| The indigo positive reflection | 37·50 |
| We get exactly | 100·00 |

which is complete absorption. The table may be used in two ways: either by graduating a prism in accordance with the numbers above given, and examining afterward the emulsified papers with this prism; or by providing a series of colored and transparent screens, each of which reproduces not only the colors of the spectrum, but also the different tones between these colors, and by then superposing each of these screens on the paper to be examined. When the colored surface viewed through the screen produces the impression of absolute black, all to be done is to subtract the value of the colored screen from 100 to obtain the number corresponding to the reflection produced by the emulsified paper. For instance, suppose a screen, through which the paper is viewed, producing thereby the effect of absolute black, to be marked 17·50; the paper should then bear the number 82·50, as that is the difference between 100 and 17·50. This formula will then signify that the paper under examination absorbs 82·50 of all the chemical rays that impinge on it, and, all other circumstances being equal, it will require more than three times as long an exposure to produce the same effect as on a paper which absorbs only 25. I have gone at some length into a description of these researches of M. Paris—researches which he has promised to continue—because they appear to me to be of a character to facilitate and improve the methods of printing which, up to this time, have depended upon formulæ or rules more or less vague and uncertain.—E. LACAN, *in Photo. News.*

## PHYSICAL SOCIETY, LONDON.

Professor G. C. FOSTER, Vice President, and afterward Prof. W. G. ADAMS, President, in the Chair.

### INTERFERENCE BANDS.

PROF. W. G. ADAMS explained a simple appliance made by Mr. S. C. Tisley, for exhibiting the colored bands due to interference with thick plates. The bands due to regular reflection and refraction were produced by two thick plates nearly parallel to each other, and fixed in a brass box with rectangular apertures on its flat faces, so that the light fell on the first plate at an angle of 60°, the whole apparatus being of a convenient size for the waistcoat pocket. On a previous occasion (June 23, 1877) Prof. Adams exhibited these bands to the society, but not in a portable form. The elliptical interference bands, due to the scattering or diffusion of light at a point on the front surface of one of the plates, were shown by means of a precisely analogous arrangement, except that the inclination of the plates to each other was somewhat greater; in this case the interference bands formed by *regular* reflection and refraction fall in another direction, so that they are not received by the eye; the diffusion interference fringes obtained were clearly visible when thrown on the screen. They are formed by rays once diffused from points on the first surface, and afterward regularly reflected and refracted from the front and back faces of the two plates in succession. Prof. Adams pointed out that this instrument would form a convenient means of obtaining polarized light in cases where the length of a Nicol's prism is objectionable, for instance, under the stage of a microscope; the light will be completely polarized if the plates be placed to receive the light at the polarizing angle, and the field will be much brighter than when a plate of tourmaline is employed.

### EDISON'S INVENTIONS.

Prof. W. F. Barrett exhibited and explained Edison's Micro-tasimeter and Carbon Telephone. In the course of a brief recapitulation of the history of these instruments he referred to Th. du Moncel's early observations, published in 1856, that variations in the resistance of a circuit can be produced by varying the pressure on metallic surfaces in contact, and after referring to Clèrac's plumbago rheostats, he stated that Edison was probably the first to apply the diminished resistance of carbon under pressure to a practical use, which he did early in 1877 in his carbon relay, the progenitor of the carbon rheostat, micro-tasimeter, and carbon telephone. In all he uses compressed lampblack, a button of which may be formed as follows: The wick of a paraffine lamp having been cut so that it smokes, a quantity of lampblack is formed in the chimney; the lower portion, which has the more intense black color, is collected from time to time, and all brown particles must be carefully removed, since they offer a great resistance. The mass is compressed into a disk about the size of a sixpence, crushed, passed through a fine sieve, and again compressed; and this operation may be two or three times repeated in order to attain a perfect uniformity. The original form of tasimeter, in which the hard rubber or other substance was placed horizontally, has been modified so that the whole is vertical. The carbon button rests on a smooth metallic surface in connection with a binding screw, and a similar conducting surface rests upon it, leading to a second binding screw. A strip of hard rubber, 1 inch long, ¼ inch wide, and ⅛ inch thick, is supported vertically above it, its upper end being attached to a fine screw worked by a tangent screw with graduated head. The whole is inclosed in a heavy conical brass box. Prof. Barrett suggested that it would be preferable to make this jacket cylindrical, and that the apparatus should be inverted, because the weight of the strip on the button is found to prevent the needle of the galvanometer returning at once to zero. Employing one Daniell's cell and inserting a shunt, Wheatstone's bridge and resistance coils in the circuit, it was shown that the hand at some distance caused a considerable deflection, and Prof. Barrett stated that in a still room the instrument becomes so sensitive as to be almost unmanageable. By replacing the hard rubber by a strip of gelatine varnished on one side a very slight change in the hygrometric state of the atmosphere can be detected by the absorption of moisture, causing expansion of the gelatine, and, therefore, compression of the carbon. Its action as an aneroid baroscope was suggested by Prof. Barrett, the button being associated with an exhausted box. He pointed out that before the tasimeter can be used as a measuring instrument, experiments must be made in order to ascertain the exact relation between the resistance of carbon and the pressure to which it is subjected. The carbon telephone was next described, and Mr. Adams, Mr. Edison's assistant, now in England, exhibited a complete transmitting apparatus, with call, etc. A very ingenious and simple form of shunt, received from Mr. Edison with the tasimeter, deserves mention. A row of brass studs fixed on a board are united by plugs, so that if the current enters at one end it can pass out at the other without meeting with any appreciable resistance. But if a plug be removed it throws in about 4 inches of a resisting wire wound over two rows of pins underneath the board, one row of which are in metallic connection with the studs. Thus the entire length of wire is in circuit when all the plugs are removed. Finally, Prof. Barrett mentioned that a communication has just been received from Mr. Edison, stating that he has succeeded in arranging an efficient receiving instrument, in which no form of magnet is employed.

### ELECTRIC LIGHT.

Mr. Ladd then showed several forms of Electric Lamp, arranged so as to render the use of clockwork unnecessary. In that known as Wallace's workshop lamp the spark passes between the edges of two plates, the lower one being fixed, while the upper one is lifted to a suitable distance by an electro-magnet, brought into action immediately on the passing of the current. A second form, in which an angular magnet was employed, acted on the same principle, the armature carrying the upper plate being specially arranged so as to give a maximum of attractive force. In the third form, the V-lamp, two rods of graphite were inclined at an angle of 45° to the vertical resting in contact on a piece of china. Immediately on the current passing an electro-magnet is caused to act, and after the rods have been firmly gripped they are separated and the support removed. Should the circuit be broken they will at once fall together.—*Chemical News.*

## THE PHYSICAL PROPERTIES OF THE ATMOSPHERE.

THE first of a course of six lectures on meteorology under the auspices of the London Meteorological Society, was lately delivered at the Institution of Civil Engineers by Dr. Mann, the subject being "The Physical Properties of the Atmosphere." Air, although essentially an invisible substance, has weight; a cubic foot weighs 573·5 grains, 13 cubic feet amount to just one pound. A room the size of Westminster Hall contains as much as 75 tons of air. The atoms of the air are of a minuteness that is perhaps quite inconceivable by the human mind. They are much smaller than the minutest molecules that can be made visible by the microscope, and have a breadth of about the $\frac{1}{190000}$ in. They exist in what is termed the gaseous state, which means that, small as they are, they float many of their own diameters asunder, from which it arises that air is compressible by the application of mechanical force. By a pressure of 15 lbs. upon each square inch, air is reduced to half its previous bulk, although water, by the same pressure, is only compressed the $\frac{1}{19000}$ part. Mariotte and Boyle have established the law that every time the pressure upon air is doubled its volume is halved. This is the obvious reason why the air is more rare and light, bulk for bulk, at the higher regions of the atmosphere, than it is near the surface of the earth. But it is also expanded by increase of temperature, and this also by a fixed law, which is that air is increased in volume $\frac{1}{459}$ part for each degree Fah.; 1,000 cubic inches at freezing temperature are increased to 1366·5 in. at the boiling point. The rarefaction of the atmosphere with ascent toward the higher regions is also effected according to a fixed law; at a height of three miles the air has a doubled volume and half its original density; it is again doubled in volume at about six miles high. It is probable that no animal could continue to live and breathe at a height of eight miles. The actual outer limit of the atmosphere is not certainly known. The weight of the entire atmosphere was first demonstrated by Torricelli when he made his memorable invention of the barometer. It amounts to the same as the weight of a column of mercury of the same diameter, 30 in. high. But mercury is 11,000 times heavier than an equal bulk of air. There is nearly one ton weight of air on each square foot of the ground. The atmosphere amounts to about the $\frac{1}{1000000}$ part of the weight of the entire earth. Air, however, presses in all directions as well as down. The air is in reality composed of two different kinds of gases, which mingle without interfering with each other by pressure. Each is, as it were, a vacuum to the other. The vapor of water rises into the interspaces of these aerial atoms in a similarly free and unconstrained way; but more of it can be sustained in warm air than in cold. Air at a temperature of 32° can sustain the $\frac{1}{130}$ part of its own weight of aqueous vapor, but at 86° it can sustain the $\frac{1}{70}$ part of its own weight. The barometer gives the combined weight of the oxygen, nitrogen, and gaseous vapor of the air, and the portion of this weight which is due to aqueous vapor is called the elastic force of vapor. With a barometer standing at 30·000 in., and with a hygrometer indicating an elastic force of vapor of 0·450, very nearly ¼ lb. of the entire pressure of 15 lbs. on each square inch is due to the vapor. When more vapor is generated than can be at once carried away, the barometer necessarily rises; when vapor is condensed in the atmosphere, the barometer falls; when the temperature of saturated air is reduced from 80° to 60°, 5 grains of aqueous vapor are deposited from each cubic foot. This is the effective cause of rain. Warm air drinks up vapor and carries it away, and subsequently deposits it when it comes to some region where it gets chilled. The temperature of the air decreases with height, about 1° for each 300 ft. or 400 ft. ascended; this is because the air gets further from the source of heat, and also because heat is absorbed above to maintain the expansion of the air. Sensible heat is lost on the expansion of air, and is produced on its condensation. Pure air is virtually quite pervious to heat; none stops in the air, but all passes through. Aqueous vapor, on the other hand, acts as a screen to heat. Prof. Tyndall has shown that 10 per cent. of the solar heat radiated from the earth through a moist atmosphere is stopped within 10 ft. of the ground. The absolute diathermancy of dry air accounts for the scorching heat of mountain tops, as the retentive power of aqueous vapor does for the soft heat of low lying regions in the tropics. The rain deluges of equatorial calms are due to the radiation of heat through the upper dry layers of the atmosphere. Cumuli clouds are formed from the same cause; they are the capitals of invisible columns of saturated air. Mountain tops are condensers of moisture for a similar reason. There is in air, besides the aqueous vapor, 3·36 parts in every 10,000 of carbonic acid gas, and 3½ parts in every 10,000,000 of ammonia. Small as these quantities appear they are sufficient to produce very astonishing results; there are 1,300,000 tons of carbonic acid, containing 371,475 tons of carbon, in the air which rests upon each square mile of the earth, and 30 lbs. of ammonia are carried down by the rain to each acre of land every year. There is one part of ozone in every 700 parts of air; but this ozone is in reality only a condensed form of oxygen itself; 3 volumes of oxygen are condensed to form 2 volumes of ozone. It is oxygen in an increased state of activity. The diathermancy and transparency of the air are both of the very highest importance to the life existing upon the earth. It is its diathermancy which enables the sun's heat to reach the terrestrial surface for the performance of its marvelous operations. It is its transparency which renders the air the window of the earth, giving man his outlook into space and admitting the wonderful effects of color and light. If the air were not transparent, all nature would be in a perpetual dense fog. The blueness of the sky is due to the weak blue rays of light being arrested by the air and its transparent vapors, and turned back upon the earth. The brilliant sunset colors are similarly due to the arrest and reflection of the stronger yellow and red vibrations, by the denser vapors of the clouds.

## REMARKABLE DISCOVERIES IN ROME—THE PALATINE HILL.

THE discoveries at Rome, of which we took notice three weeks since, were completed by a series of explorations among the ruins on the Palatine Hill—the most celebrated among the famous Seven—and beneath the site of Hadrian's Villa. The Palatine Hill, or Rock, formerly covered by the villas of the rich or the gardens of impenetrable monasteries, became of recent years one among the most brilliant promenades in the Italian capital. Below it, however, was supposed to exist the real Palace of the Cæsars, and to unearth one of these was long ago an ambition on the part of archæologists. This classic eminence is a strong mass, about 2,000 yards in circumference, and from 90 to 100 ft. high—the smallest, albeit the most renowned, of the Seven. Its interior has in many ages been ransacked for mosaics, statues, and other artistic relics, but without any great results until Napoleon III.—from whom the Italian government subsequently repurchased the ground—bought the Farnese Gardens, which occupied the northern slopes. Many events intervened between the projects then announced and the work of which, within the last few weeks, the results have been announced. They go far beyond any that were anticipated. In the first instance, as we have noted, the Palace of the Cæsars was the grand monument sought to be exhumed; but, in seeking for this, all that remains of the City of Romulus was also brought to light, though even the most fervid antiquarians had given up every hope of coming upon a trace of it. The legend of the plow cutting a square outline has in some respects been justified, and the conjectural topography established as true.

The way which led to these explorations was singular. A steep street, of comparatively modern construction, ascends the historical hill; beneath it were detected traces of another, striking apparently through the heart of it; this was followed, and a magnificently paved roadway laid bare, when it was found that the foundations of the imperial edifices sought for had been built upon the remnants of others more ancient still—Cyclopean in their massiveness, almost savage in their achitecture. Rome was always a city of walls and gates. One of the latter, reared far below the Arch of Titus, pointed out several paths which the explorers were not slow to follow.

The first led to the ruins of, unquestionably, a temple, surmised to be that dedicated to Jupiter Stator, every vestige of which was believed to have been obliterated by the corroding process of time. It bears a Sabine date, and is a wonderful testimony to the traditions preserved by Livy.

Near at hand some few and faint traces would seem to indicate the house of the first Tarquin, but their identity is not insisted upon by either the French or the Italian excavators, though they admit no doubt concerning the fact of their having discovered the genuine city of Romulus, with which, of course, the great Roman history begins.

More interesting still, and less ambiguous, are those remains suggesting the spot on which stood the Temple of Vesta, upon whose altar flamed, unextinguished from year to year, the Sacred Fire. Close to them are the Tombs of the Vestals, or, at least, sepulchers agreeing in every respect with the description of the historian.

Passing these the second gate of the Palatine was reached—the Roman gate opening upon the Street of Victory, above which stands, in our days, the uncouth Church of St. Theodore. Here was picked up a little image of a she-wolf, in bronze, identical in every respect with one which has long been kept as a priceless curiosity in the museum of the Capitol.

Further on is a relic more remarkable still—supposing its authenticity to be credited—the house, or rather the hut, of Romulus, the wolf-suckled, and founder of Rome. Of course, it is possible that many of these discoveries may have a suppositious value attached to them, but the site being, in a general sense, absolutely unchallengeable, the probabilities become all the less reasonable.

The explorers sought in vain for anything suggestive of where stood the altar of Hercules, or the staircase of Cacus, yet they are confident of having approached, with more or less accuracy, their sites, and they insist that these identifications may be accepted without, in any manner, adopting the legendary annals of primeval Rome. The evidence of the wall is incontestable.

Mighty blocks of sandstone, corresponding in a great degree with the substance of the hill itself, piled one upon another without cement, holding together simply by their own weight, arranged in regular tiers, according to their different lengths, and, as a result, strongly Etruscan in character. Nothing could well be more instructive than this, as throwing light upon the annals of a much debated period, for a whole world of architecture and art is illustrated in the recesses of that Roman hill. Nothing which has been left to us by Etruria is equal to that which has been bequeathed by the professed imitators of Etruscans. Even that relic of Servius, which breaks through the surface of Mount Aventine, surpasses all that the Tuscan territory can show. It is clear that these builders—the labors of whose hands are being thus disinterred—were not barbarians in the proper sense of the term. They possessed, at any rate, the instincts of grandeur, and of harmony in proportions, to a high degree. Moreover, these masses of masonry are found to bear peculiar marks—indicating sometimes the rocks whence they were quarried; at others, the places for which they were destined—many of the former being situated at a considerable distance. The inscriptions are not painted, but cut deep into the stone, and utterly abolish the claim of those on the tombs of the Scipios to be regarded as the earliest inscriptions on the monuments of Rome, or in the Latin language anywhere.

Many temples, new to the light of modern discovery, but old in the memory, as it may be termed, of tradition, have been restored by these French and Italian explorers to the light: That of Jupiter the Conqueror; of the Peace Goddess, who reconciled quarrelsome households; of the Mother of the Gods, whose image was every year solemnly bathed in the Tiber.

Next is distinguished on the new plan of the Palatine Hill the House of Cicero, with the Portico of Catullus—the former razed, by a decree of Claudius, during the orator's exile, though restored some years later by the Senate, at a cost of £16,000 of our day. Both, however, appear to have been confounded with a beautiful building called, for no reason that we can perceive, the Baths of Livy, adorned with ornamental ceilings, groups of statuary, and painted arabesques on grounds of gold, out of all consonance with the simplicity attributed, as a rule, to the period of the kings. By degrees, however, the palaces of Augustus covered the hill, and their very basements, buried among the ruins of the earlier epoch, hid them from view. It was only by burrowing beneath them that they could, so to speak, be rediscovered.

At the commencement, of the true Palace of the Cæsars only a commonplace house, after the Roman fashion, was made out amid the wilderness of destruction; next it was proved to have been encircled by stone colonnades—for marble had not then entered into the system of Roman architecture—and the structure thus grew, by uncontemplated degrees, into its ultimate splendid form. In the very midst of it, indeed, a miniature temple, dedicated to Vesta, has been recognized by those unfailing signs which antiquarians know.

Of the Imperial edifice itself—built in two stories—many parts are choked with rubbish, others empty; some are beautifully paved with slabs of marble attached to the walls by clamps of *steel*. Fragments of lovely sculpture are said, too, to have been fallen upon; but, before the age of Augustus, marble was rarely used in Roman architecture. The boast of the Cæsar, "I found a city of brick, and shall leave one of marble," was literally justified. By "brick" he meant "terra cotta," and a prodigious amount of it has been penetrated by the excavators in the bosom of the Palatine Hill.

But, as appears from the inscriptions already alluded to, when Rome began to be built of marble, it was from no neighboring quarries, but of materials brought from the ports of Greece and Asia, Alexandria, and Carthage, and for the carriage of these prodigious blocks special vessels had to be constructed, as numerous medals, turned up during the late excavations, testify. In fact, some of the stone cut from the rock for this purpose was in the form and size of monoliths, obelisk-shaped, and long buried beneath the dust of Imperial Rome. Little of it, however, was marble; the vast proportion, in point of dimensions and weight, being granite. And amid all this ponderous architecture, covered over with dust and surmounted by the celebrated Hill, have been raked up metal blades and scabbards, pieces of lead piping, evidently for the distribution of water, and "eyes" for the reception, it would seem, of rails for stair carpeting.

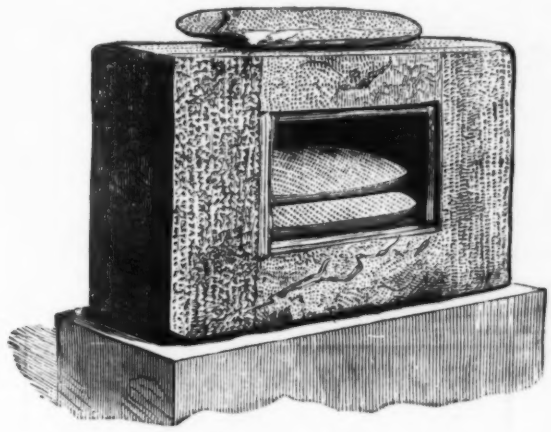
These lead up to noble chambers, with elegant cornices, with arabesqued walls, with sculptured garlands of flowers and fruit frescoes—five in a line—windows open, though of course not glazed, and hypothyral courts, whose arrangement must have been remarkable in every sense, and suggestive of equally remarkable manners on the part of those whose lives were passed among them—walls of lime-white, bordered by strips of gray, trellises of metal, artificial birds'-nests, representing the fancies of an Epicurean age: the whole opening upon a long street-like perspective, not unlike that of the unburied Pompeii, but furnished with terraced roofs and, in contrast, roofed balconies—a picture by no means ideal, for M. Boissier has just found it reproduced on a coin, or medal, exhumed from amid the lately illuminated ruins. Beyond all this, some examples have been amassed of an art utterly strange to European knowledge until now—two magnificent mythological pictures—the one representing "Polyphemus and Galatea," the other, "Mercury delivering Argus"—the giant tumbling amid the waves, the nymph wearing a red mantle, clinging to a black-maned horse, and exhibiting a purity and whiteness of flesh on the uncovered parts of her body and limbs perfectly startling to those who have imagined that the primitive builders of Rome were little better than savage. The hills in the distance are beautifully clear, the trees surmounting them in shadowy perspective, the waters below transparent.

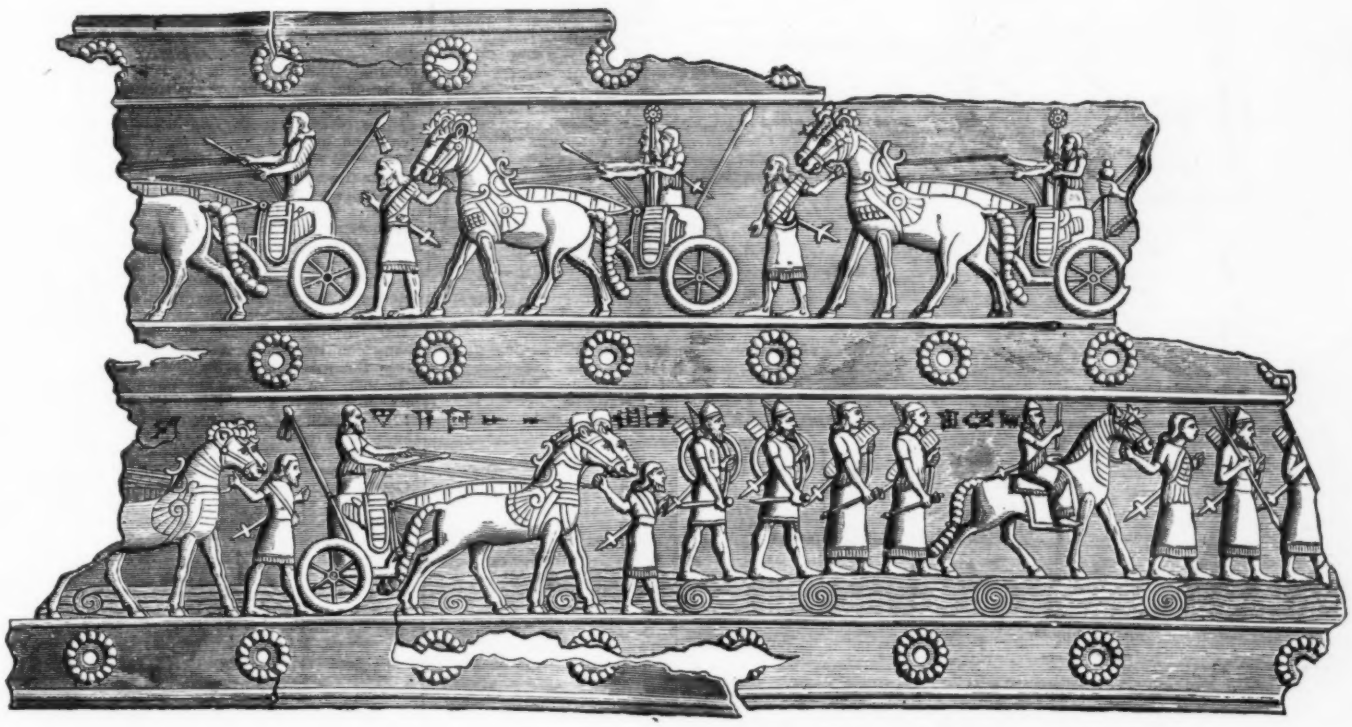
All this, assuredly, was not what these latest explorers expected to find. "There is nothing like it at Pompeii," writes M. Helbig, than whom a more competent critic of ancient painting does not live. "It suggests that these antique Romans must have gone to school with the Greeks." However, palaces, porticoes, streets, open in an immense perspective, until the stages of the artistic and architectural history rise, as it were, one above another, and the most luxurious epoch of Imperialism has been reached. Strangely enough, nothing is left of Nero, either upon the inhabited surface or in the disemboweled Palatine Hill. Yet it was his ambition to rear a palace "which should be a city in itself." But the narrow rock, already covered with temples and mansions, left no room for his desire, so he determined to erect his sumptuous "Folly" elsewhere, with its fountains of gold-work, ivory tables for guests, and so forth. None of this, however, belongs to the newly exhumed antiquities of the Palatine Hill, though the realities concerning the famous "Golden House" might not be unworthy of an examination by themselves. But, as generations went by, the mania—the malady, Plutarch calls it—of building upon that hill increased, though so little of its monumental glory escaped burial in the earth during a long series of ages—some of it, and the most important, perhaps, even until the present day.

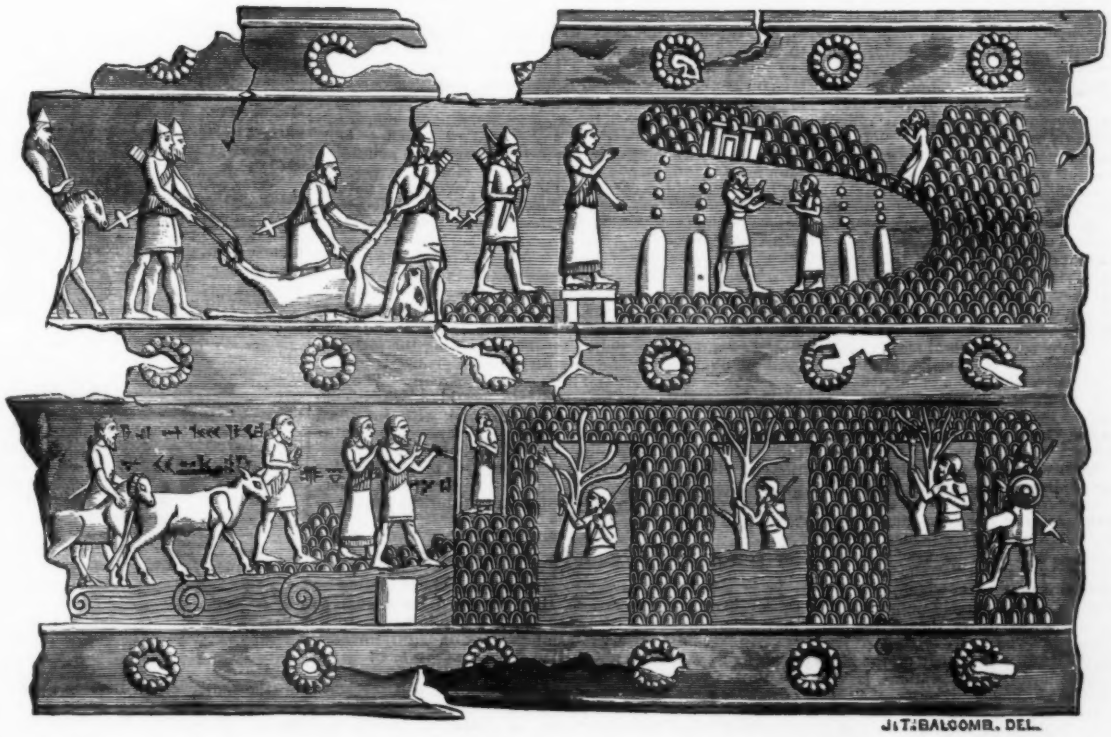
The Palace of Domitian, however, still exists where Nero refused to reside—a vast vestibule, a superb reception-hall, a systematically-arranged series of corridors on either side, a labyrinth of rooms for various purposes above, and a peristyle in the purest taste. The whole is now open to the gaze of day, with its groups of colossal sculpture, columns of many-colored stone, and masses of inimitable ornament. Such a new light was not expected, after the exhumation of Pompeii, to be thrown upon the arts and manners of the ancient world, and yet these discoveries date, so to speak, from yesterday.—*The Building News.*

## RECENT ASSYRIAN DISCOVERIES.

SOME interesting articles in the *Times*, and in several other daily journals, toward the end of last August, described the important discoveries made in the spring of this year by Mr. Hormuzd Rassam at Balawat, nine miles northeast of Nimroud (Kalakh), and fifteen miles from Kouyunjik, on the Tigris, the site of ancient Nineveh. Mr. Rassam, a native of that country, but a naturalized British subject, and long in the service of our Foreign Office, was the assistant of Sir Austen Henry Layard, now her Majesty's Envoy at Constantinople, in the famous explorations of Nineveh and Nimroud, about thirty years ago, which contributed the first installment of relics of the Assyrian historical monuments to the British Museum. Since the lamented death of Mr. George Smith, who had carried on the work partly for the British Museum, partly at the cost of the proprietors of the *Daily Telegraph*, the Museum authorities have commissioned Mr. Rassam to pursue these researches, from which he has already obtained some valuable results. He came home last summer, bringing some collections which are now in the Museum, and a portion of which, from Balawat, are the subject of our present illustrations. A lecture explanatory of these sculpture records of Assyrian history was delivered last week to the Society of Biblical Archæology, in Conduit street, by Mr. Theophilus Pinches, the successor of Mr. George Smith at his post in the Oriental Antiquities Department of the Museum. He described the mound of Balawat as the site of an ancient Assyrian fortress, which had borne a different name before the reign of Assur-nazir-pal, father of Shalmaneser II., whose reception of tribute from Jehu, King of Israel, is recorded on the famous black obelisk. Though so close to Nineveh, it had been taken and held by the Babylonians during a period of Assyria's political decline, perhaps coincident with the epoch of Hebrew ascendency. But when Assur-nazir-pal, a great warrior, came to the throne, he recovered the city, and renamed it Imgur-Beli, and built there a temple to the god of war, near the city's northeastern wall. These facts are recorded on alabaster tablets found by Mr. Rassam in a coffer of the same material near the entrance of the temple itself. As Mr. Pinches remarked, they shed a fresh ray of light on one of the darkest periods of Assyrian history. The mound is nearly rectangular, and its

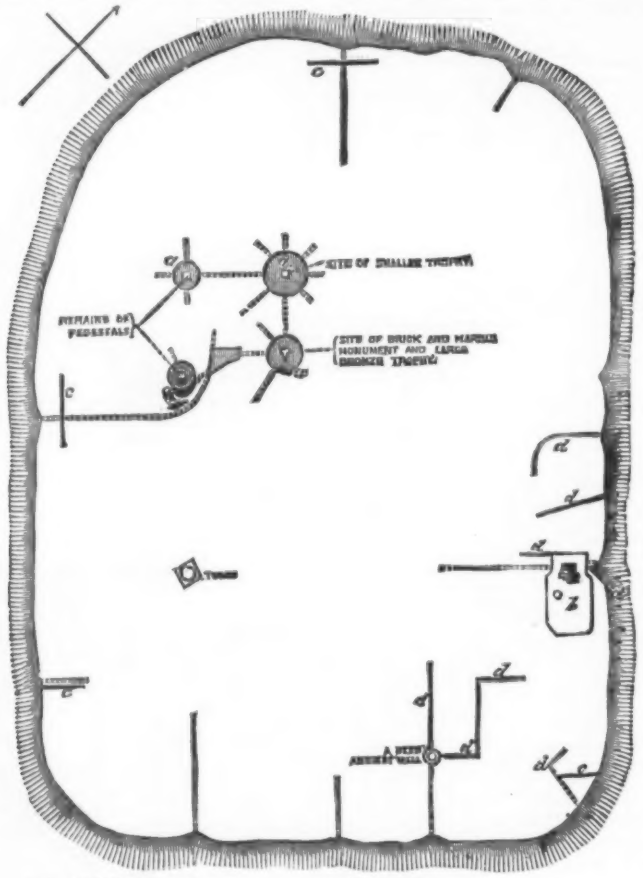







RECENT ASSYRIAN DISCOVERIES.—BRONZE SCULPTURES OF GATES, AND ALABASTER CHEST WITH TABLETS, NINEVEH.

corners are turned pretty accurately toward the four cardinal points of the compass. The temple ruins lie near the north-eastern edge, where ran the city wall. In the western half of the mound four stone platforms were found marking the sides of an irregular square. While digging round these platforms Mr. Rassam unearthed some pieces of chased bronze, and at length two huge bronze monuments slowly came to view. They were of the strangest shape. Each seemed formed of a center-piece with seven long arms on either hand, like colossal hat-racks, with which the first published accounts compared them. Even after laying them bare, the energetic excavator had great difficulty in disinterring them, and was mortified at hearing the precious bronzes split and crack as the sun dried up the earth in which they had lain buried so many centuries. According to the explorer's ground plan, the platforms mark the entrances to the courtyard of a noble palace, having two entrances on the northeast and two others on the northwest. The bronzes arrived at the British Museum at the beginning of August last. There they met with an enthusiastic welcome, and no less naturally




*a* Circular ditches.
*b* Marble altar, with platform and seats in original position
*c* Old aqueducts.
*d* Trenches.
The double dotted lines are the tunnels.

## RECENT ASSYRIAN DISCOVERIES.

called forth much speculation as to their nature and use. To Mr. Ready, the ingenious artificer of the department at the British Museum, whose task it was to see to the cleansing of the fragments, piecing them together, and nailing them with the original bronze nails on wood of the same thickness as that which underlay the plates thus fastened, belongs the merit of solving the riddle. He was the first to see that the bronze plates of the larger of the two monuments had formed the coverings of an enormous pair of rectangular folding doors, each about twenty-two feet in height and six feet broad, which had evidently turned on pivots, and were held up at the top by strong rings fixed in the masonry. The body of the doors was of wood three inches thick, as measured by the nails, which are found to be clinched a little more than that distance from the heads, the overplus being just the thickness of the bronze plates themselves, which is about one-sixteenth of an inch. Each door revolved on a circular post about a foot in diameter. Each post had a pivot at the bottom. The pivots are at the Museum, but the sockets in which they turned were unfortunately left behind. The bronze plates are about eight feet long. They were nailed horizontally across each door, but, allowing for their extension round the post, the total length across each leaf was but six feet. What is technically termed the "style" of each leaf was also overlaid with a bronze edging, which overlapped the door by about a couple of inches. On the right it is cut plain, but is indented on the side overlapping the back of the doors. The smaller pair of gates is much more decayed than the other. Its designs represent hunting scenes, and it belongs to the same reign as the larger, whose inscriptions are those of Shalmaneser II. The representations on the plates of both pairs are in the repoussé style. Those on the plates of the great gates depict Shalmaneser's battles, sieges, triumphal processions, the tortures inflicted on his prisoners, and his worship of the gods. The bronze plates covering the "styles" of the doors are also engraved with historical inscriptions, of which, reserving for another time his account of the extremely numerous and interesting designs chased on the doors themselves, Mr. Pinches gave the general purport. The record on the "styles," he observed, though somewhat fuller than that on the black obelisk, and than the Kurkh and Bull inscriptions, is very carelessly executed, even the chronological order of events having been to some extent inverted. The new document begins with Shalmaneser's Babylonian campaign, when he went to help King Marduku-Suma-Iddin against that Babylonian monarch's revolted brother. Next, it places his war in the region of Mount Ararat, followed by that against Gozan, and his triumph over Akhuni, King of Borsippa, which paved the way for his conquest of Syria and Palestine. A critical comparison of all the sources proves, however, that the Ararat campaign came first, and then his expeditions against Akhuni and the Babylonian war. In concluding, Mr. Pinches held out the hope of identifying, in his future paper on the bass-reliefs (which greatly exceed in number those in the Nimroud Gallery in the British Museum), some Jewish faces of the ninth century, before Christ. It is certain that, as he remarked, this wonderful monument cannot fail to be of great use to the ethnologist, as well as to the philologist and the antiquary.

The late Mr George Smith's excellent summary of the "History of Assyria," published by the Christian Knowledge Society, tells us the events of Shalmaneser II.'s reign, from B.C. 860 to B.C. 824. He continued and maintained the conquests of his father, Assur-nazir-pal, the builder of the palace at Nimroud, who had marched his army to the Mediterranean sea coast, and exacted homage from Tyre and Sidon. The military expeditions of Shalmaneser II. likewise conducted him into Syria, and led to the series of conflicts related in the Second Book of Chronicles, in which Israel and Judah became fatally involved, but at a considerably later period. This circumstance gives a share of Biblical interest to the actions delineated in the bronze sculptures, of which we present some illustrations. They show the King with his army on the march; warriors standing in two-horse chariots, like those of Homer's heroes at the siege of Troy, the horses led by footmen; the King riding on horseback, wearing a loose robe and cap, with attendant eunuchs before and behind him, and men carrying his bows and quivers, wading across the River Tigris. Then, in a piece below, the King appears standing to offer sacrifices upon an altar; the captain of his guard is behind him, with soldiers who are bringing a slaughtered bull and a live ram for the offering. There are four conical stones, the well-known emblems of a common object of Eastern nature-worship; there is a sacred grove of trees, with a lodge or temple in the background, and the guardian priest is talking with the King's herald or secretary, who may perhaps be asking leave to approach or enter the sanctuary. The nethermost scroll would seem to represent the King's servants cutting an inscription on the rock, and lopping a few branches of the trees, to commemorate his visit to the foreign shrine. This was situated, most likely, in Northern Syria, and there would be a motive of policy for thus recording the pious regard of Shalmaneser for the divinities worshiped by the nations over whom his ambition sought to reign. The alabaster chest, three feet long and two feet high, which contained three alabaster tablets, all covered with inscribed history of the reign of Assur-nazir-pal, is represented at the top of the page. A ground plan of Mr. Rassam's excavations at Balawat is also furnished, and we may expect the publication of his own account of them, as well as Mr. Pinches' further interpretation of their historical import.—*Illustrated London News.*

## THE CHAMELEON—HOW IT CHANGES COLOR.

IT is scarcely necessary to give a detailed description of those singular little lizards, the *Chameleons*, inasmuch as they are undoubtedly very old acquaintances to all our readers. In fact nearly every elementary work on natural history gives figures of these animals, and the text never omits an account of one of their most remarkable characteristics—the power they possess of changing their color at will.

Many theories have been advanced to account for this change of color, the importance of which, by the way, has been grossly exaggerated. It is popularly supposed, for instance, that these animals can assume, indifferently, in a few seconds, the color of surrounding objects, and that they make use of this faculty for the purpose of concealing themselves from their enemies. But this idea is very erroneous, for carefully-conducted experiments have shown that chameleons are powerless to modify their external appearance so rapidly and in so marked a manner. Under the influence of certain exciting agents, such as heat, light, and electricity, or under the domination of certain passions, they are only able to cause a variation in the tints of their body—to make it pass from one shade to another belonging to the same chromatic series, or to efface, or render visible, the blotches that are found on various parts of their body, particularly their flanks. But this is a very different matter from those wonderful changes described by authors, who have allowed a brilliant imagination to interfere with the correctness of their observations.

In 1835, M. Milne-Edwards discovered that the coloring matter of the skin of these animals was not limited (as in mammals and birds) to the deep layers of the epidermis, but that they were in part spread over the surface of the derm, and in part buried still more deeply and distributed in a

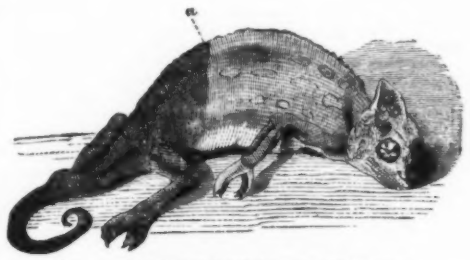



FIG. 1.—Chameleon with spinal marrow divided at *a*.

series of small contractile pockets of a special structure. M. Brücke, in 1851, recognized these same contractile corpuscles, but, unlike Milne-Edwards, he did not attribute the changes of color to the particular distribution of the pigments; he believed that the deep cells of the epidermis, spread out in thin plates, likewise played a certain part in the production of the phenomena of interference. By careful experiments he became convinced, too, that the nervous system exercised a direct influence on the coloration of the integuments. More recently still, M. Ponchet has studied, microscopically, the anatomical conditions of color variation, not only in reptiles, but also in fishes and crustaceans. Under the "chromoblasts," described by Milne-Edwards, he has detected a remarkable layer that he terms *cærulescent*, and that possesses the singular property of appearing yellow on a transparent ground, and blue on an opaque one. In the chameleon, this blue, mixing with a fixed yellow pigment, gives the green tint. Finally, alongside of the blackish cells there are also other chromoblasts, which contain a red or yellow matter, and the play of which modifies the shade of the integuments. By experiment, M. Ponchet found that the faculty possessed by certain animals of putting their bodies in relation with the intensity of the light reflected by their surroundings was destroyed by the extirpation of the eyeball, or by cutting the optic nerve; it appeared then to be due to what physiologists term a reflex action, and seemed to depend on some influence exercised from a distance on

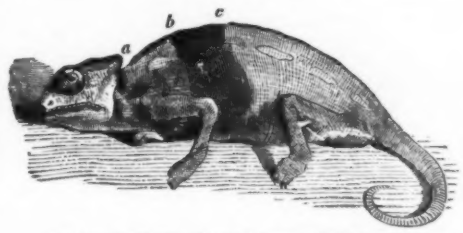



FIG. 2.—Chameleon with spinal marrow divided at *a*, *b*, *c*.

the elements of the central nervous system. To determine how this transmission was effected, M. Ponchet cut the cerebro-spinal axis and its dependent nerves in several places, and discovered that the communication between the chromoblasts and the brain was not effected through the lateral nerve, but that the trifacial nerve played a certain part in the changes of color, and this he proved by experiments on young turbots. Finally, he concluded from all his experiments that the great sympathetic nerve governs the *chromatic function*, and that this is the medium of communication between the brain and the chromoblasts, and that this causes the dilatation or the contraction of the pigment cells. During all this time M. Paul Bert had been likewise experimenting on the chameleon, and the results of his work, communicated, in 1875, to the Society of Biology, have been finally presented, in the form of a memoir, to the French Academy of Sciences. These experiments shed a new light

FIG. 3.—Chameleon asleep; illuminated by a powerful light; the back protected by a paper pattern.

on the subject. M. Bert, in the first place, has verified all the work done by his predecessors, but he does not stop there. By cutting the spinal marrow of the chameleon near the middle (Fig. 1, *a*) he rendered the animal half green and half black, the darker shade covering the anterior part of the body; then, by making an incision at the neck, he effected the almost immediate darkening of the head and the anterior part of the body, the nerves of which, designed for the colored corpuscles, have their origin between the third and

sixth dorsal vertebræ, and follow the passage of the great sympathetic of the neck. Moreover, after cutting the marrow, the energetic excitation of a mixed nerve brought about, by reflex action, a brightening of the skin, especially of the corresponding side. By making two or three incisions of the marrow (Fig. 2, *a*, *b*, *c*), and applying excitants at *b* and *c* directed in opposite ways, M. Bert saw the whole body assume a clear green tint, with the exception of the region innervated by the portion *b c*, which remained black. After the extirpation of the two cerebral hemispheres, the optic tubercles, or the cerebellum, the change of color was no longer produced spontaneously, but was only effected when the animal was excited. The destruction of a single cerebral hemisphere, causing the loss, of course, of the opposite eye, produced on the corresponding side a much more rapid and much more durable variation of tint than upon the opposite side, and the excision of the sound eye had no effect in restoring the equilibrium. Not so, however, when, instead of suppressing the cerebral hemispheres, one of the eyes simply was removed; in this case the corresponding side remained much clearer than the one containing the sound eye, and the suppression of the opposite eye effaced all difference of color between the two halves of the body. It had been previously remarked that during sleep and after death the body of the chameleon assumes a yellowish color, and that under the influence of light it becomes of a darker shade. Supplementing these observations, M. Bert discov-

FIG. 4.—Chameleon awake; anterior part receiving the rays through red glass, and the posterior part through blue glass.

ered that light not only influences the dead and sleeping animals, but that it also curiously modifies their color while they are awake. The phenomena are manifested equally when the light is transmitted through dark blue glass, but cease completely when red or yellow glass is used. To render his experiments more striking M. Bert hit upon the following device: By means of a lamp he threw a strong light on the back of a sleeping chameleon, having previously protected a part of the back by a cut paper pattern; he thus obtained the curious appearance shown in Fig. 3. By placing another animal, which was wide awake, in the sunlight, and placing over the fore part of the reptile a red glass, and over the back part a blue glass, he divided the body into two very distinct regions, one of a clear green color with reddish blotches, and the other of a blackish green with very prominent markings (Fig. 4).

From all these facts M. Bert draws the following conclusions: (1.) The colors and various shades of color that chameleons assume are due to changes in the position of the colored corpuscles, which are buried beneath the skin and form an opaque ground beneath the cœrulescent layer, or are distributed superficially over the skin, leaving it either of its yellow color, or making it green and black. (2.) The movements of these chromoblasts are determined by two sets of nerves, one of which causes them to start to the surface, while the other sends them back again into the interior of the integuments.

The result of these researches leads M. Bert to believe that he may possibly discover thereby why it is that the direct action of light on the skin of children and lymphatic people has such a beneficial effect as regards their health.

## INSECT FUNGI.

In the SCIENTIFIC AMERICAN SUPPLEMENT, No. 149, page 2376, under the caption of "A Curious Fungus," Mr. W. H. Gibson gives an interesting account, accompanied by a sketch, of a fungus found by him sprouting out from the chrysalid of an insect. As the author saw the object rather with the eye of the artist than that of the botanist, it is not surprising that his drawing fails to show the essential features of the plant, although his description gives evidence that these did not escape his attention; we refer to the prominent brownish-yellow papillæ with which the club-shaped, orange colored head is studded. These are not well shown in the sketch.

The fungus that Mr. Gibson found is known to botanists as *Torrubia miliaris*, and is a parasite on the pupæ of buried moths, from the interior of which it emerges, gradually and finally depriving the pupa of life in the course of its growth. Had the writer sliced the head of the fungus, either horizontally or vertically, he would have observed, near the margin, a number of small roundish cells containing little flask-shaped vessels (*perithecia*), within which the fruit is generated. These little flasks are provided with necks (*ostiola*), which puncture the surface of the head of the fungus, and through an opening in these the sporidia are ultimately excluded. It was these necks, then, brownish yellow in color, that thickly studded the surface of the fungus. Had the perithecia, or flask-shaped bodies, been examined with the microscope, they would have been found to contain a great number of long, transparent cylindrical sacs (*asci*), attached by their bases to the walls of the perithecium, and each containing eight long threadlike jointed sporidia. The whitish powder observed by the author consisted of these broken joints of the excluded sporidia. Sometimes the fungus maintains throughout its whole existence a state very different from that described in the present instance. Instead of producing a club-shaped head, a smaller, more delicate and friable white stem grows up, which is usually branched, and the whole surface is covered with a white powder, as if it were flour or chalk. No fruit, such as we have just described, is produced; nothing save the white dust, which consists of minute cellular bodies termed *Conidia*. This conidiiferous condition was for a long time regarded as a distinct fungus, and under the name of *Isaria farinosa* is still alluded to in some works, as though it had an independent existence. A Brooklyn entomologist sent us a specimen of this form not long since for identification. About twenty-five species of this genus of insect fungi are known from all parts of the world. Five species are recorded in South Carolina, one in Pennsylvania on the larvæ of the May bug (*melolontha*), and one other North American species of a curious kind on pupæ of nocturnal lepidoptera. The most splendid species of the genus, however, are found at our antipodes. In conclusion it may be stated that Mr. Gibson will probably meet with no success in reproducing the fungus from the sporidia. There is something curious connected with the growth of these organisms; its spores may germinate, and may produce a *mycelium*, but the latter may remain for years without fruiting. The spores of the mushroom will not germinate till they have passed through the body of a horse or cow; those of other fungi may float around, and eventually perish, unless they should chance to alight on the proper object to serve as a nidus for their growth and development. The sporidia of the *Torrubia* under consideration are undoubtedly taken into the body of the flying moth, and only germinate and develop into fruit when the latter becomes a buried chrysalid.

## AMERICAN DAIRY PROGRESS.

By J. R. DODGE.

THE International Dairy Fair in New York attests the growing importance of this rural industry. It is proper to assume that it will not be an occasion for mutual admiration, and it is to be hoped that it may not prove one of mere glorification over past successes. Much improvement has been made, and more is still needed. The cheese factories, fairly in operation in 1857, only twenty-three in number in 1860, increased to 1,313 in 1870, and have since been rapidly extending to the West, and to Virginia and North Carolina in the South. In 1874 New York alone had 1,139 for cheese and butter. While the product has been improved in quality and uniformity, it is by no means up to the standard of attainable excellence, especially in keeping, seldom improving by age beyond a brief period. There is also more good butter, though quite too much of it, as heretofore, is simply abominable. It might be exported in far larger quantities were the quality better. The export price, 17½ cents twenty years ago, and 18 cents last year, tells the true story of

BAD BUTTER,

after a small quantity of strictly gilt-edge has been taken for the use of the most fastidious at home. A judge of good butter may try a carload of packages, and find only a few of passable quality; he may not find one that adds to positive excellence. With much help in recent years from scientific experiment, acquired practical skill, and superior knowledge of requisite conditions for success in dairying, a desirable degree of neatness in milking, if not in manufacture, is still exceptional, and a high degree of perfection of known methods and attainable products phenomenal. Outside of districts in which dairying is a specialty, there is still more carelessness and less skill, while in large sections of the South the art of cheese making is unknown, and attempted practice of butter-making beneath the dignity of an art. Viewed from a high standpoint there is very much to be dissatisfied with; considered with reference to the positive and steady advances made, there may be danger of self-satisfaction and suspension of effort. There is one thing the convention should do promptly, that is, suppress its too

EFFUSIVE STATISTICIANS,

lest we have further estimates of a butter production of 1,440,000,000 pounds per annum, an amount that could not be produced were all the milk used in cheese-making and in the families of farmers and city residents utilized to increase the butter supply. Then the usual convention-estimates of an aggregate value in dairy products of $600,000,000, properly discounted one third when made, at present prices should be reduced very nearly one half. The cheese export of last year was larger than the census record of the entire product in 1860, but the value both of butter and cheese exported was only $18,034,369; the former at 18 cents, the latter at 11·4 cents per pound. The real figures are quite respectable, but they cannot be stretched to cover the flat creation of two or three hundred millions by wild enthusiasts. The era of

INFLATION OF DAIRY ESTIMATES

should now close with the coming of "resumption." These wonderful butter estimates are made by assuming that 5,000,000 of people eat each one pound per week, 10,000,000 three-fourths, 10,000,000 half a pound, and so on a very convenient substitute for a census, with the unfortunate drawback that it requires eighteen to twenty millions of cows, when we have only twelve by any reasonable manipulation of State or National statistics. By assuming that the cows of the Gulf States (whose owners go all winter without milk in their coffee while their herd browse in the cane-brakes) average as large a yield for the year as those of New York, these oleaginous adepts in dairy figures are able to limit their creation of cows to 15,000,000. The assumed yield of 450 gallons per annum for each cow in the country, in the everglades of Florida and on the plains of Texas, as well as in the best dairy districts, is utterly preposterous. While there are a few extra milkers yielding twice the actual average yield, no man of judgment can place the average of New York much above 475 gallons. The following gives the result of analyzing the

NEW YORK CENSUS STATISTICS OF 1874:

| | |
|---|---|
| 107,873,361 pounds butter, or.... | 323,620,083 gals. milk. |
| 7,778,413 pounds cheese, or.... | 9,074,815 gals. milk. |
| Sold in market..... | 41,511,599 gals. milk. |
| Sold to butter and cheese facto's. | 110,482,849 gals. milk. |
| Product of 1,301,879 cows..... | 484,689,346 gals. milk. |

This gives an average of 372 gallons per cow. Deducting 216,253, one cow for every farm, for milk used in families owning cows, the average would be raised to 446 gallons. A few of the best dairy States may average 450 gallons per cow: others, in which dairying is an interest of some prominence, probably 400 gallons; the middle belt of States scarcely 300 gallons; the cotton belt less than 200 gallons actually obtained from each animal designated a cow; and the true average of the whole country would not probably exceed 325 gallons. The most thorough investigation of all attainable facts bearing upon average yield, will lead irresistibly to the conclusion that

THE TRUE AVERAGE FOR THE COUNTRY

cannot exceed two-thirds of the average rate of yield in New York. The rapid increase of the foreign demand, especially for cheese, affords a strong stimulus for higher quality as well as for large production in the future. The export of cheese during the war was fourfold greater than for the preceding period of five years; instead of declining after the fall of the gold premium, it continued to advance, and the shipments of the past two years exceed those of the five years from 1861, and double those of the thirty years from 1820 to 1851. The price of cheese exported is about 25 per cent. higher than twenty years ago, but it is cheaper, the difference in quality being greater than in price. It averaged 9 cents in 1858; in 1878, 11·4 cents. Butter fluctuates greatly in its foreign movement. The tendency is toward increase, moderate between 1820 and 1876, but much stronger for the two years past. Much of this export is of low grade. About two-thirds go to Great Britain. The British West Indies, British Guiana, Porto Rico, and Cuba are our best customers. The following shows the number of pounds of

DAIRY EXPORTS FOR TWENTY YEARS:

| Year ended June 30. | Butter. | Cheese. |
|---|---|---|
| 1858 | 3,082,117 | 8,098,527 |
| 1859 | 4,572,065 | 7,103,323 |
| 1860 | 7,640,914 | 15,515,799 |
| 1861 | 15,531,381 | 32,361,428 |
| 1862 | 26,691,247 | 34,052,078 |
| 1863 | 35,172,415 | 42,045,054 |
| 1864 | 20,895,435 | 47,751,329 |
| 1865 | 21,559,892 | 53,154,318 |
| 1866 | 3,806,835 | 96,411,985 |
| 1867 | 4,912,355 | 52,352,127 |
| 1868 | 2,071,873 | 51,097,203 |
| 1869 | 1,324,332 | 39,960,367 |
| 1870 | 2,019,288 | 57,296,327 |
| 1871 | 3,965,043 | 63,698,867 |
| 1872 | 7,746,261 | 66,204,025 |
| 1873 | 4,518,844 | 80,366,540 |
| 1874 | 4,367,983 | 90,611,077 |
| 1875 | 6,360,827 | 101,010,853 |
| 1876 | 4,644,894 | 97,676,264 |
| 1877 | 21,527,242 | 107,364,666 |
| 1878 | 21,834,141 | 123,783,785 |

This trade should grow rapidly in the future. Recent improvement and rapid extension of dairying in the West will, by competition, keep prices moderate and quality advancing, low prices will stimulate both home and foreign demand, and new markets will be opened. But progress should still be the watchword of dairymen.—*New York Tribune.*

## LECTURE ON HYGIENE.*

By REGINALD SOUTHEY, M.D. OXON., F.R.C.P., Physician to, and Lecturer on, Forensic Medicine and Hygiene, at the Hospital.

GENTLEMEN:—The chapter of hygienics I open to-day—Poisonous Infecting Principles as the Determining Causes of Disease—may, I hope, prove interesting and profitable to you. Fertile or communicable disease is man's own fault, indeed may be regarded almost as the penalty incurred by ignorance, indolence, and vice.

The specific contagia are known only by the reactions or symptoms of disease which they produce. I cannot show them all to you labeled in bottles, or under microscopes, although certain of them have been so far separated and attached to lymph as to be carried about on ivory points, while others can be shown to exist by experiment in a mere drop of fluid.

The specific contagia all have two phases of existence—an active and a dormant state. In their active state they multiply themselves, and communicate change to living fluids or tissues into which they pass; in their dormant state they simply resist destruction. There may be, perhaps, three stages in the life history of every contagium—a germ or seed stage, a plant or organism stage, and a fructifying or flowering stage.

ZYMOTIC DISEASES.—At the outset we perceive that the reactions or symptoms determined or developed by different contagia differ in several respects. Thus, one class of infective poisons render the body inapt for future turmoils or changes of the same kind; they enter the body, and leaven the whole mass; as crops produced by vegetable seed, they exhaust the soil, and, at all events, leave an impression or effect behind them which is slowly, rarely, or never afterwards effaced. They enter the body and shut the door upon themselves. The term zymotic has been attached to the diseases thus provoked, and we can take no exception to the term as a descriptive one. Small-pox, syphilis, measles, scarlet fever, typhus, and typhoid, are of this kind.

SEPTIC DISEASES.—The other class of infective poisons provoke their peculiar or specific reaction directly they enter the body, but the change they determine in it leaves this more, rather than less, prone to future reactionary disturbance of the same kind. The disease they provoke does not secure future immunity: the soil is left fertilized, rather than sterilized, by these germs having intruded themselves; the door is left open for fresh raids. Septicæmia, pyæmia, erysipelas, gangrene, ague, and gonorrhœa, are diseases determined by this class of poisons, which may be very properly called septic.

DIFFERENCE IN THE DEVELOPMENT OF DISEASES.—Experiments show that out of apparently harmless materials, and with the fulfillment of certain essential conditions, septic poisons of well-established virulence can be developed. But one of the conditions proves to be the addition of bacteria germs, and, although these are omnipresent in ordinary air and water, they cannot be pretended to be spontaneously developed; they are derived always from pre-existent bacteria. The zymotic contagia, so far back as the history of disease extends, never appear to have originated *de novo;* like has always produced like; and wherever any outbreak of zymotic disease has been investigated with sufficient care, its arrival has been traced to some previously infected person or clothing.

Towards the identification of different diseases, precise definitions, stating what nexus of symptoms and pathological changes shall be held to constitute the particular malady to which a particular name is attached, are required.

By specific disease I wish you to understand me to mean not syphilis merely, but every disease that answers completely to any special and appropriate definition. The number of diseases of which our knowledge can be affirmed to be complete is not so very many, but when a disease is constant in form, regular in all its phases, true to type in all its relations, or varies from its prototypes very insignificantly, it may be termed specific. When one and the same con-

* Delivered at St. Bartholomew's Hospital, London.

tagium or poison enters animal bodies similarly constructed, endowed, and chemically constituted, the results are, within small variation, the same. Like produces like in the human body, just as surely as in the mixture of two test fluids in the laboratory. Indeed, the symptoms of the several contagium-determined diseases differ really less than do many chemical reactions. Every communicable or infective disease may be as reasonably assumed to have a special poison entity of its own as to possess separate or specific existence.

That you may gain precise ideas about these specific poisons, and the reaction they excite, I wish you to study them as you would any other well-ascertained poison. First, as to local and remote action. The local action, except in the instance of the distinctly enthetic poisons, like vaccination, hydrophobia, the septic prick or dissection wound, is attended by slight apparent disturbance, and no very particular sensations; but there is a remote action, provoked in common by both septic and zymotic poisons, when these have profoundly altered the normal nutritional interchanges. The sense of cold and collapse is what I refer to, and the tendency to death by asthenia or failure of the heart's action.

There are further features of difference between the zymotic and septic poison-determined reactions in the human body to which I desire to direct your attention. The zymotic contagium, be this what it may—some modified blood or soluble animal cell, some fungus or low vegetable germ, zoospore, or microspore—requires cooking or hatching for a certain period of time in the individual who has received it before any apparent change or reaction can succeed. Some period of incubation must elapse during which the poison infects or impregnates the whole system before this manifests its presence by symptoms; but when the reaction is manifested it is general at once throughout the body. So soon as the poison begins to work its changes, indefinite symptoms may arise, such as are common to all grave blood changes, and are non-appointing. You will have often heard me say at the bedside that a patient appears to me suffering from a general reaction to some one of the exanthemata contagia, which one I cannot tell until the rash comes out.

Three stages may thus be distinguished in the history of zymotic poisoning—(*a*) a dormant stage without symptoms; (*b*) an incubating stage with general symptoms; (*c*) a specific stage with special appointing symptoms.

No such separate stages can, I think, be observed in disease produced by septic poison. It is true that the poison of erysipelas, septicæmia, hydrophobia, sometimes lies latent in the body into which it has been inserted, but this latest period is non-essential; nay, rather it may be regarded as accidental, for from the first instant the poison reaches vulnerable surfaces, the reaction commences, the body is forthwith infected. A late or deferred reaction is apparently only due to encapsulation of the poison at the poison wound, its separation really from the body by a limitation barrier. Within such a capsule the poison germs lie like seeds inside a seed-case. Furthermore, in septic disease the reaction process first manifests itself at the point where the virus is inserted, and spreads from this focus, gathering force as it goes. There is no incubating stage—the specific symptoms follow at once. We perceive next that the quantity of virus or poison inserted makes absolutely no difference to the total sum of the reaction or specific symptoms provoked in the instance of zymotic disease, whereas both the form and quantity of the septic poison materially influence the course and gravity of the reaction induced. Finally, in both septic and zymotic disease we perceive a conflict between the stability of the poison entity and the stability of the person poisoned, but a conflict with this remarkably different issue, that the zymotic poison always vanquishes the body and leaves its stamp or mark upon it, whereas the septic poison is either vanquished and cast out, or obtains predominance, corrupts and destroys the individual.

The conditions which modify symptoms or reactions in the example of ordinary poisons should be well remembered by those among you who attended this special part of my course on Forensic Medicine. They were:—1st. *The form and quantity of the poison.* This holds true of the septic but not of the zymotic poisons. 2d. *The site where the poison gains entrance into the body.* This affects the period of reaction—the time which elapses between the infection and the development of the symptoms—but certainly not the nature of the reaction in zymotic disease, and probably not in septic disease. 3d. *The condition of the individual infected, idiosyncrasy, present state or habit of body.* That this influences the reaction in the cases of both zymotic and septic poisoning is certain.

The processes of disease set in motion by septic poisons begin by local manifestations at the spot where the poison is inserted and extend from thence, and as the pathological process travels onwards, implicating further tissues, those first involved may, as we see constantly in erysipelas, have shaken off the poisonous reaction. The septic reaction, then, travels from a focus, and, as a rule, gathers strength as it extends—*vires acquirit eundo.* Far otherwise is it with the zymotic reaction. This begins at the periphery, not at the center of insertion; and from the first moment that the specific poisonous effects, as of measles or small-pox, are manifested, there is no part of the body free from contamination.

Now it is highly probable, as Dr. B. Sanderson's experiments tend to show, that septic animal poisons gather virulence or poisonous energy by every separate living organism that they pass through. He showed that fluids taken from the abdominal cavity of animals in which peritonitis had been artificially produced—*i. e.*, traumatically induced, as by injection of caustic ammonia, would serve, if brought into contact with the peritoneum of a sound animal, to provoke peritonitis in the latter. With the fluid, again, derived from this second animal (B), in his series, a third (C) was inoculated, and so with several animals in succession, each deriving the poison one from the other. He observed that the poison gained in virulence, so that smaller quantities produced death, and this death followed at a shorter period from the insertion of the poison in the animals that were inoculated latest in the series. The experiments were of a most instructive nature: for in the reaction induced in the early cases, when the poison might be regarded as most crude or least distinguished from a mere traumatic fluid, metastatic abscesses or scattered pyæmic deposits were provoked; whereas in the cases late in the experimental series the animals died quickly, manifesting those pathological changes which appoint pure septicæmia.

It has been long since ascertained that by overcrowding patients in hospitals and allowing a surplusage of purulent and stinking wounds in hospital wards, pyæmia, septicæmia, dysentery, hospital gangrene, and accidents *de pourriture* can be provoked. Further events follow too: ordinary complaints which usually are not dangerous assume a low typhoid form; tonsillitis and diarrhea prevail among the nurses and attendants; erysipelas follows the slightest skin lesion; and peritonitis succeeds nearly every parturition. The medical officers of lying-in hospitals inform us that peritonitis after parturition is one of the most communicable poisons with which they are acquainted, and that cases of distinctly traumatic peritonitis have apparently given origin to epidemics of puerperal peritonitis of greatest malignancy.

It appears to me that Dr. Sanderson's investigations and experiments justify me almost in assuming that the form and quantity of septic poisons influence the course and issue of septic disease. Now I am jealously skeptical always of the idea of a conversion of one animal poison into another, but I am ready to admit that at the spot where a septic poison is planted on the body, the nature of the absorbing surface must modify the dose, and may, therefore, influence the reaction, and thus lend an altered aspect to the symptoms. These, however, it influences in degree, but not in kind. It may be pleaded that one and the same poison planted on a tonsil would provoke tonsillitis of a low, malignant type; that, having alighted on the intestinal tract, it might excite diarrhea or dysentery; falling upon an abraded surface, gangrene; reaching the interior of a vein, thrombosis; entering a lymphatic channel, erysipelas. This variation of the reaction according to the site upon which the poison germ alights is for some persons a very attractive theory; but there are certainly no grounds for this belief in cases of zymotic poisoning, and I should advise you to remember that it is wholly unproved so far as the septic contagia are concerned.

I do not pretend to draw a line, myself, between septicæmia and pyæmia; but between erysipelas and septicæmia, puerperal peritonitis, gangrene, and dysentery, all septic diseases, I perceive at least distinction enough to hold each specifically separate.

Each infective disease whose symptoms are precise and definable may with reason be attributed to a special determining cause or specific virus. There is probably less difference between the specific poison germs which provoke the different septic diseases, than between those which determine the distinct zymotic diseases, and because septic disease does not sterilize the land before it, two or more septic poisons may provoke their reaction in the same body simultaneously. But no two zymotic poisons implanted on the same individual at the same time ever run their course together; one only can fructify or incubate. Either the syphilis or the vaccination reaction will ensue, the small pox or scarlet fever, the chicken pox or measles, the enteric fever or typhus; but no crosses. No hybrid diseases are possible. This appoints the universal influence of the poison at the period of reaction.

From facts recorded of infection and poisoning by communicable disease, it is reasonable to believe that different, animal contagia have different atomic forms, different atomic weights, distinct vitalities, resist destruction differently; are some direct or immediate, some indirect or intermediary in their course from their starting to their sticking point, from their discharge from the first infected individual to their arrest in the wounded person. Let us inquire into all these matters.

For communicable disease to spread, three things are requisite: (1) an infecting poison, an animal cell or graft, some germ or microspore, or some potential fluid; (2) some means of connection or insertion of this poison; (3) receptivity or aptitude in the person who receives this poison.

If the atomic form of the poison is large, it may be believed to be heavy; the larger, the heavier, and more tangible it is, the less readily will it travel from person to person. The contagiousness of the disease communicated will, therefore, appear immediate or most direct; those nearest in contact with the infected person will suffer most. If, although heavy, its vitality is great, it may be conveyed about by clothes or fomites. If its vitality is small and it is quickly destroyed by diffusion through air or water, it will not travel far and must be inserted quickly in a fresh body to provoke its special reaction.

There is much reason to think that the plague poison, syphilis poison, the small pox and typhus poison, is of this heavy form and low vitality. But the poison of cholera and typhoid fever is probably an example of a lighter, subtler substance, and one of greater vitality; since, although sometimes carried into the body by food or water contaminated by human alvine excreta, the cholera poison is probably also borne in the blue mists observed in most cholera epidemics; and neither the cholera nor the typhoid poison appears to be destructible, although diluted in any quantity of cold water. The syphilis poison probably quickly loses its vitality or propagating powers; once dried, I believe its life history is ended. But the variola and varioloid poison may be dried, and, if neither frozen nor overheated, like mummy grain, it will certainly retain its infecting properties for years. So, too the scarlet fever, yellow fever, plague, and typhoid poisons can lie dormant in a drawer or cupboard for weeks, or months, or years, awaiting the conditions which shall favor future development. The plague is said to have broken out afresh after a hundred years in consequence of the reopening of a plague pit.

While most poisons are direct, although of greater or less vitality, it is possible that some require the fulfillment of some special developing conditions between the time of their discharge from one individual and their insertion into another.—*Lancet.*

[London Lancet.]

## MALARIA AND AGUE.

IN the *Lancet*, of October 5, my attention was drawn to an article with the above heading, written by Staff Surgeon H. F. Norbury, in which he cites a case of ague caused, he believes, by inhaling the odor of decaying vegetation. After nearly twenty years' experience of tropical fevers, I cannot say that the evidence in this case is at all conclusive that the fever was necessarily produced by the cause mentioned, and I doubt if malaria is ever caused by decaying vegetation. It is possible that when Dr. Norbury was standing on the heap of decayed Opuntia, he was at the same time in the neighborhood of either newly turned up soil or of ground recently denuded of vegetation. From a "heap" of Opuntia being mentioned, I suspect that a portion of the dry, arid ground on which plants of that species thrive had been recently cleared, and possibly turned, emanations from which, under a tropical sun, I consider much more likely to cause fever than the decaying plants; or, perhaps, during the four days which elapsed between the exposure and the attack of fever he may have encountered some other exciting cause, as twenty-four hours is usually sufficient for the development of an attack of malarious fever. I have known localities surrounded by rice fields, mangrove swamps, and tidal mud, where there is always a large amount of decaying vegetation, perfectly free from malarious fevers. I have never noticed that persons living in the vicinity of rank vegetation or rice fields suffer particularly from fever so long as the growth in the one case is left undisturbed, and in the other while the crops are growing or the ground is covered with water. I know that it is a popular idea that rank vegetation, such as jungle, is necessarily unhealthy, and "breeds fever." But I think on careful inquiry it will be found that neither the forests of Borneo nor the jungles of Assam, nor damp, thickly-wooded districts generally, were considered unhealthy or fever-producing, till the vegetation was cut down. Witness the unhealthiness of the Assam tea-gardens when the virgin forest is first cleared away, and it is a fact that one may sleep with perfect safety in the Borneo forests if you keep away from, or to the windward of, the clearings. The same holds good with the forests of North America. When the settlers penetrated into the woods, and began to clear the ground, ague made its appearance. In regard to rice fields, so long as the rice is growing, and the field is covered with water, there is no fear of malaria; but when the rice is cut, and the ground begins to dry up, with no vegetation on it, then fever makes its appearance in the vicinity. I lived for nearly six years in a house the wall of which rose sheer out of a rice field, and I never suffered from fever, nor did my servants, who lived and slept not three feet above the level of the field; but these fields were always under water, summer and winter.

I consider the most fruitful source of malarious fever to be exposure to the emanations arising from recently turned up virgin soil, or from ground from which the vegetation has recently been removed. The fevers which used to decimate our troops in Hong Kong were certainly not caused by malaria arising from swamps, decaying vegetation, or rice fields, as neither the one nor the other of these so-called producers of malaria was to be found anywhere in the vicinity of the barracks, but in every direction roads were being made and sites for houses being leveled; in fact, newly turned-up ground, the unfailing source of malaria. The danger of opening the ground is now recognized by the local government, and cutting of the cliffs or road-making is entirely suspended during the hot season in the neighborhood of the city of Victoria. One of the finest sites in the island for a sanitarium, viz., Sia-wan, was hastily abandoned by the military authorities because it was reported to be malarious. The unhealthiness, no doubt, arose from the newly-leveled ground having been built upon, and the houses inhabited before the vegetation had had time to grow and clothe the extensive slopes of freshly-turned soil. The cause of the unhealthiness of the station was at the time of its desertion ascribed to the neighboring rice fields and tidal mud; but as these lay some 300 feet below and nearly a mile from the barracks, they could have had very little influence.

The outbreak of fever in Cyprus may, perhaps, be accounted for if road-making and leveling of the ground have been going on during the hot weather in the vicinity of the camp.

To counteract in some measure the evil effects arising from the emanations from newly turned-up soil, the ground should be freely sprinkled with dry lime, and, where feasible, beaten hard into what is called in the East "chunam," or, better still, covered with turf. At the same time vegetation should be encouraged to grow as rapidly as possible.

Florence, Oct. 31, 1878. G. DODS.

## CHLORAL AS A COUNTER-IRRITANT.

AMONG the many uses to which chloral has been put, we have not met before with the following from the *Bulletin Thérapeutique:* Made into a mass with gum tragacanth, spread on paper and applied to the skin, it will produce a blister without pain. Applied as a powder, on cotton, it causes a painful burning sensation. By the former method a portion is absorbed, and the patient falls asleep. Its action is not so uniform as cantharides, but as a mild vesicant, or an agreeable revulsive, the author quoted would commend such "chloral paper" to physicians, the more so as it will keep for months without losing its activity, if well prepared.

## HARMLESSNESS OF UREA IN THE BLOOD.

THE London *Medical Record* mentions experiments by MM. Feltz and Ritter, to show that pure urea never brought on convulsive symptoms. Urea injected into the blood was eliminated very rapidly by the urine, and when it existed in considerable quantities in the organism it did not, as generally supposed, undergo a rapid transformation into carbonate of ammonia. Dogs into which urea was injected, after the renal vessels were tied, to prevent the rapid elimination of the poison, showed no more marked convulsive symptoms than others in which the same ligature was made without the injection. The convulsive symptoms observed with urea were produced by an impure substance containing ammoniacal salts. The authors summed up in the following conclusions: 1. Pure urea, whether natural or artificial, injected into the venous system in large quantities, never brings on convulsive symptoms; it is rapidly eliminated by the secretions. 2. There are no ferments in the normal blood which convert the urea into ammoniacal salts. The rapidity of elimination cannot be regarded as the cause of this non-conversion, for by the suppression of the renal secretion the elimination of the urea may be retarded without accelerating the supervention of the eclampsia. The urea which in large doses brings on convulsions is always impure urea which contains ammoniacal salts, which are easily shown to be present by Nessler's reagent.

## GASTRIC JUICE OF THE DOG FISH.

CH. RICHET has examined the gastric juice of the dog fish and other carnivorous fishes. The digestive agent of these animals is not a fluid, but a slimy, coherent material, scarcely miscible with water, which under the microscope consists of an amorphous substance, with scattered epithelial cells. When a large quantity of water is added to it, it dissolves, and may be filtered. It contains more free acid than the gastric juice of mammals, the quantity estimated as hydrochloric acid amounting to even 10 or 15 per thousand. The bases contained in the juice are not sufficient to salinate the hydrochloric acid, which agrees with Schmidt's statements in regard to the acid of the gastric juice of the dog. Yet it is not completely free; its state of combination appears to be similar to that obtained when hydrochloric acid is added to glycocol, leucin, or albumen.